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62-11

# Highway Safety Literature

An Announcement  
of Recent Acquisitions. . .

HSL No. 71-23  
August 27, 1971



THIS ISSUE CONTAINS:  
HS-009 574 - HS-009 676  
HS-810 174

HSL No. 71-23

August 27, 1971

HS-009 574 - HS-009 676, HS-810 174

# HIGHWAY SAFETY LITERATURE

## AN ANNOUNCEMENT OF RECENT ACQUISITIONS

Published Bi-Weekly (26 times a year) by the National Highway Traffic Safety Administration  
Washington, D.C. 20590

### INTRODUCTION

Publications announced in *Highway Safety Literature* include the most recent additions to the collection of the NHTSA Scientific & Technical Information Service. Subject areas covered include all phases of highway, motor vehicle, and traffic safety, especially those encompassed by the National Traffic and Motor Vehicle Safety Act of 1966 and the Highway Safety Act of 1966.

Individual issues of *HSL* are numbered according to the year and the issue number within that year; thus, 71 designates the year and 1, 2, 3, etc. the individual issues. To aid the user in location citations by the HS-number, the cover bears the inclusive entry numbers for each issue.

Entries in *HSL* are arranged according to the revised NHTSA Subject Category List shown in the Table of Contents. The List is a two-level arrangement consisting of five major subject fields subdivided into 58 subject groups. Documents related directly to the National Highway Traffic Safety

Administration (NHTSA) are announced in a separate section headed NHTSA DOCUMENTS and are numbered in five distinct series: NHTSA Accident Investigation Reports (HS-600 000 series), NHTSA Compliance Test Reports (HS-610 000 series), NHTSA Contractors Reports (HS-800 000 series), NHTSA Staff Speeches, Papers, etc. (HS-810 000 series), and NHTSA Imprints (HS-820 000 series). For NHTSA DOCUMENTS in series HS-600 000 and HS-610 000, individual full case reports are available for inspection at the National Highway Traffic Safety Administration. HS-800 000 series and HS-820 000 series are available for purchase from NTIS or GPO (see page ii). Although announced together in a separate section, these documents are also assigned specific subject categories for machine retrieval.

A document which contains a number of separate articles is announced as a complete volume in the subject category most applicable to it as a whole. Entries for the individual articles appear in their most specific subject category.

### SAMPLE ENTRIES

#### Subject Category Array

NHSB Accession no..... HS-800 218 Fld. 5/21; 5/9  
Title of document..... AN INVESTIGATION OF USED CAR  
SAFETY STANDARDS-SAFETY  
INDEX: FINAL REPORT. VOL. 6 -  
APPENDICES G-L  
Personal author(s)..... by E. N. Wells; J. P. Fitzmaurice; C. E.  
Guilliams; S. R. Kalin; P. D. Williams  
Corporate author..... Operations Research, Inc.  
Collation.....  
Publication date..... 12 Sep 1969 150p  
Contract FH-11-6921  
Report no. ORI-TR-553-Vol-6; PB-190  
523  
Abstract..... Appendices G-L to this study of used  
car safety standards include: indenture  
model diagrams for classes I-IV motor  
trucks; degradation, wear, and failure  
data for motor truck classes I-IV; and  
safety index tables for classes I-IV  
motor trucks.  
Search terms: Wear; Trucks;  
Failures; Used cars; Inspection  
standards

HS-004 497 Fld. 5/19

#### AUTO THEFT-THE PROBLEM AND THE CHALLENGE

by Thomas A. Williams, Sr.

Journal citation . . . Published in *FBI Law Enforcement  
Bulletin* v37 n12 p15-7 (Dec 1968)

Gives figures on the extent of the  
auto theft problem and comments on  
antitheft devices available now or in  
the planning stage.

Search terms: Theft; Theft protec-  
tion; Stolen cars

AVAILABILITY: NTIS

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\* All Federal Motor Vehicle Safety Standards apply to passenger vehicles. An asterisk before a subject group indicates additional types of vehicles to which the indicated standards may apply.

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NOTE: Material published in Highway Safety Literature (HSL) is intended for the information and assistance of the motor vehicle and highway safety community. While brands names, equipment model names and identification, and companies may be mentioned from time to time, this data is included as an information service. Inclusion of this information in the HSL should not, under any circumstances, be construed as an endorsement or an approval by the U. S. Department of Transportation, National Highway Traffic Safety Administration of any particular product, course, or equipment.

Harry A. Feinberg  
Managing Editor

## AVAILABILITY OF DOCUMENTS AND INSTRUCTIONS FOR ORDERING

Department of Transportation personnel may borrow copies of publications directly from the NHTSA. Outside the Washington, D.C. area, phone (202) 426-2768. In Washington, D.C. area, use government ID, phone 118-62768. Non-DOT personnel should contact their company or agency libraries for assistance.

Journals cited may be obtained through most research libraries.

Contractors' reports and other documents can usually be obtained as indicated under AVAILABILITY. However, there is no certainty that retention copies will be available for more than a limited period after a document is issued.

The more common distribution sources are identified by symbols which are explained below:

**NTIS:** National Technical Information Service, Springfield, Va. 22151. *Order by accession number: HS, AD, or PB.* Prepayment is required by NTIS (CFSTI) coupon (GPO coupons are not acceptable), check, or money order (made payable to the NTIS), *HC* (Paper copy; full size original or reduced facsimile) \$3.00 up; *MF* (microfiche approximately 4x6" negative sheet

film; reader required) \$0.95.

**GPO:** Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402. Give corporate author, title, personal author, and report number. Prepayment is required by GPO coupon (NTIS [CFSTI] coupons are not acceptable), check or money order (made payable to the Superintendent of documents).

**HRB:** Highway Research Board, National Academy of Sciences, 2101 Constitution Ave., N. W., Washington, D. C. 20418.

**NHTSA:** National Highway Traffic Safety Administration General Services Division, Washington, D.C. 20591 (Telephone (202) 426-0874),

**SAE:** Society of Automotive Engineers, Dept. HSL, 2 Pennsylvania Plaza, New York, N.Y. 10001. Order by SAE report numbers. Prices given are list; discounts are available to members and sometimes to libraries and U. S. Government Agencies. Prepayment is required; orders without payment are subject to a \$1 handling charge.

## IMPORTANT NOTICE

WHEN REQUESTING a document, to be absolutely sure you receive what you order, give the accession number (HS, PB, AD number) or report number (in cases such as an SAE document), title of report, and the personal or corporate author (whichever is cited). When requesting an HS-numbered document from NTIS (CFSTI), add DOT/to the prefix HS-; example HS-800 000 should be ordered as DOT/HS-800 000.

**1/0 ACCIDENTS****1/1 Emergency Services****HS-009 574** Fld. 1/1**EMERGENCY MEDICAL SERVICES AND POLICE OFFICERS**

by Oscar P. Hampton, Jr.

Published in *Police Chief* v37 n9 p38-41 (Sep 1970)

The essentials of first class emergency ambulance services are listed, and an approach for citizens to take in acquiring such services is outlined. Local governments should consider assuming responsibility for these services. A community council should decide what type of service is needed. The use of police and fire department vehicles as ambulances, the regulation of ambulance service, and the place of the helicopter as an emergency ambulance are discussed.

Search terms: Emergency medical services; Ambulances; Ambulance laws; Ambulance personnel training; Helicopter ambulances; Community support; Police vehicles; Firemen

**1/2 Injuries****HS-009 575** Fld. 1/2; 1/3**ACCIDENTS AMONG THE AGED: INCIDENCE, CAUSES AND PREVENTION**

by Manul Rodstein

Published in *Journal of Chronic Diseases* v17 p515-26 (1964)

12 refs

The incidence of fatal accidents in people aged 65 and over is presented. breakdown of these fatalities by categories is compared with the figures for the general population. Accidents due to falls, burns and scalds, gas and asphyxia, drugs, and automobiles, are analyzed in relation to predisposing causes, place and

time of occurrence, and methods of prevention. Most accidents did not result in serious injury. However, individuals in whom serious injury occurred often had a history of a series of prior accidents with little or no injury. Multiple and major accidents were most common among the weak, confused, chronically ill, and those suffering from various physical disabilities. The greatest number of accidents occurred during those times of day when activity was maximal, especially at the time of arising and going to bed. A discussion of the problems of aged drivers and pedestrians is included.

Search terms: Accident studies; Age factor in accidents; Accident proneness; Accident severity; Accident types; Age factor in driving; Aged drivers; Aged pedestrians; Pedestrian accidents; Fatalities

**1/3 Investigation****HS-009 576** Fld. 1/3; 1/1; 4/3**HEALTH PROGRAM ANALYSIS REVIEW GROUP FOR SELECTED DISEASE CONTROL PROGRAMS. MOTOR VEHICLE INJURY PREVENTION AND EMERGENCY HEALTH SERVICES. REPORT OF 1967**

Public Health Service

Aug 1967 115p refs

A cost effectiveness study of six highway safety program areas was made. The program units are: decreasing driving exposure by drinking drivers; restraint systems for motor vehicle occupants; medical aspects of driver licensing and driver evaluation; motorcycle injury prevention, especially wearing of helmets; reduction of pedestrian injuries through safety education of the aged and young children; and emergency health services improvement.

Search terms: Benefit cost analysis; Highway safety programs; Safety program effectiveness; Accident preven-

tion; Motorcycle safety; Alcohol usage deterrents; Drinking drivers; Pedestrian safety; Motorcycle safety; Helmets; Restraint systems; Driver license standards; Driver physical fitness; Aged pedestrians; Child safety education; Emergency medical services; Injury prevention; Fatality prevention

**HS-009 577** Fld. 1/3; 1/2**FIELD EXPERIENCE AND EVALUATION OF TAD PROJECT "VEHICLE DAMAGE RATING SCALE"**

by William S. Rouse; Francis Gendre

North Carolina Univ. Hwy. Safety Res. Center

Dec 1969 39p 5 refs

Reprinted from *Proceedings of the Thirteenth Stapp Car Crash Conference*, New York, 1969, p215-36.

The TAD vehicle damage rating scale was field tested for several months in North Carolina. A test of inter-rater reliability for highway patrolmen using the TAD scale showed there is relatively good agreement among raters as to damage type and severity level. Problems in the use of the scale are noted. A second test involved psychological scaling of the TAD manual pictures and showed that the various TAD scales lacked the desired scale characteristics of equal appearing intervals. A sample of 1,329 accident reports was obtained and comparisons made among damage ratings, speed, and estimated damage cost adjusted for vehicle age as predictors of driver injuries. The tests showed that speed is less effective a predictor than either the TAD scale or cost. Cost estimates were as good in predicting driver injury as the TAD scale under some conditions, but the TAD scale proved superior for discriminating serious injuries from minor (or no) injuries.

Search terms: Damage severity index; Damage costs; Damage estimation; Psychological factors; Injury predic-

### 1/3 Investigations (Cont'd.)

#### HS-009 577 (Cont'd.)

tion from vehicle damage; Correlation analysis; Injury severity index; Accident severity index; Speed patterns; Accident analysis

#### HS-009 578 Fld. 1/3

### THE PRICE OF NOT WALKING OR "A SYSTEM FOR CHEATING DEATH ON MINNESOTA HIGHWAYS"

by G. B. Caples; R. C. Vanstrum

Minnesota Mining and Mfg. Co.

Sep 1969 68p 177 refs

The purpose of this report is to provide a method for improving government decisions designed to reduce motor vehicle accidents. It is recommended that Minnesota should study accident rates in terms of accidents per mobility, a concept including both speed and mileage; that the continuous recording of vehicle speeds should be expanded; that skews in speed distribution should be used to forecast dangerous locations; that automatic speed detection and photographic documentation should be employed; that the legal definition of alcoholic impairment should be amended to define impairment by the age of the person; that field of view and fatal accident rates should be studied for correlations; that mathematical models to predict the effect of proposed remedies should be devised; and that more fatal accident data should be used to expand the analytic method used in this report.

Search terms: Aged drivers; Minnesota; Priorities; Accident causes; Driver intoxication; Male drivers; Female drivers; Accident location; Age factor in accidents; Mathematical models; Adolescent drivers; Drinking drivers; Accident prevention; Driver sex; Night driving; Accident rates; Fatality rates; Decision making; Speed patterns; Speed recorders; Field of

view; Highway improvements; Vehicle mileage

#### HS-009 579 Fld. 1/3; 4/5

### AUTOMATING TRAFFIC-ACCIDENT RECORDS

by William T. Baker; Roy B. Sawhill

Published in *Trend in Engineering at the University of Washington* v16 n2 p14-8 (Apr 1964)

7 refs

A group of electronic data programs was developed to assure a workable approach for agencies engaged in analyzing traffic accidents. Some of the programs are high-speed sorting routines that merely present and summarize data in an orderly manner so that it may be analyzed; others, such as the correlation program, actually do the analyzing. Seven programs are described; two of them, the distribution and intersection programs, are covered at some length.

Search terms: Traffic accidents; Computer programs; Accident records; Electronic accident analysis; Intersection collisions

#### HS-009 580 Fld. 1/3

### THE CASE FOR FAST DRIVERS

by Robert L. Schwartz

Published in *Harper's Magazine* v227 n1360 p65-70 (Sep 1963)

Contrary to common belief, fast drivers are not the worst menace on the road. Studies have shown that on rural highways, reducing speed limits has resulted in a significant increase in accidents. This report criticizes the lack of objective research into the causes of accidents, which is less than \$5.00 per victim compared with the sum of \$100,000 per victim spent on air crash research. One notable exception in the area of accident research is the work being conducted at

Harvard Medical School which researchers fatal accidents. Their findings indicate that most fatal accidents are the result of a number of small things, relatively insignificant by themselves, which team up to cause a fatal accident. An accident case study is given; there were at least four causes, but the police report attributed the accident to "speeding."

Search terms: Accident causes; Fatality causes; Accident studies; Accident research; Speed limits; High speed; Accident rates; Speed limit effectiveness; Accident case reports; Accident investigation; Multidisciplinary teams

#### HS-009 581 Fld. 1/3

### AN ACTION PROGRAMME AGAINST DEATH ON THE ROAD

by A. R. Berrange

Published in *Robot* n5 p4-7 (Aug-Sep 1970)

A systems analysis approach to reduce the number of traffic fatalities is presented which recognizes speed as a factor common to all accidents. Control of the vehicle speed, an improved system for informing the driver of his speed, and detection of violators are important factors in this program. Roadways would be given hazard ratings and speed limits designed to maintain a predetermined number of fatalities per hundred million vehicle miles of travel. Systems would also be developed to inform the driver if he exceeded speed limits. Excessive speeding would be detected and recorded with an appropriate penalty against the driver.

Search terms: Systems analysis; Speed recorders; Speed indicators; Speed limit effectiveness; Accident rates; Highway accident potential; Accident risks; Accident prevention; Traffic law enforcement; High speed caused accidents

HS-009 582 Fld. 1/3

# **KREML PROPOSES 3-POINT TRAFFIC ACCIDENT PRE- VENTION PROGRAM**

by Franklin M. Kreml

Published in *Traffic Digest and Review*  
v18 n8 p11, 13-4 (Aug 1970)

In describing the problem of traffic accidents, it is not the drunk driver, reckless driver, or the accident-prone driver who is the problem. Rather, they are the manifestations of social problems that exist today. The steps that the Federal government, particularly the National Highway Safety Bureau, can take, and what must be done by state and local officials to reduce the number of traffic accidents are discussed. Emphasis on driver training programs and vehicle inspection programs is not the answer. The answer lies first in a high quality, completely selective program of traffic law enforcement; second, an accelerated program of vehicle improvement and application of highway safety design and traffic control standards; and third, a concerted upon the fundamental social problems such as the growing abuse of alcohol and drugs.

Search terms: Drinking drivers; Reckless drivers; High risk drivers; Accident proneness; Accident prevention; Highway safety programs; Driver education; Traffic law enforcement; Safety design; Highway safety; Accident proneness; Vehicle inspection; Sociological factors; Alcoholism; Drug addiction

HS-009 583 Fld. 1/3

# **PHOTOGRAMMETRIC RECORD- ING OF ACCIDENT SCENE IN- FORMATION**

by H. Q. Avera

North American Rockwell Corp.

Sep 1969 27p  
Report no. C9-1783/030

A simulated accident was photographed under controlled conditions so that the photographs could be used for precision measurements later. In addition, a series of photographs were taken from various angles for stereoscopic viewing. The feasibility and practicality of taking and viewing stereoscopic photographs of accident scenes were demonstrated.

Search terms: Stereophotography; Accident simulation; Photogrammetry; Photographs; Accident reconstruction

## **1/5 Statistical Data**

HS-009 584 Fld. 1/5

# **THE SMALL CAR IN MOTOR VEHICLE TRAFFIC ACCIDENTS IN ILLINOIS 1962**

Illinois Div. of Highways

Oct 1963 15p

The results of an analysis to determine the differences between accidents involving small cars and other passenger cars in the state of Illinois in 1962 are reported. The driver death rate per 10,000 registered small cars was more than double that for other passenger cars. The passenger death rate for small cars was more than 50 percent greater than the corresponding death rate for other passenger cars. The greatest proportionate representation of persons killed in mishaps involving only small cars was of the 20-24 age group as compared to the 35-44 age group for other vehicles. The number of persons killed per vehicle in traffic accidents involving the small car was a fifth greater than it was for accidents involving other passenger cars. Small cars show a higher rate of overturned on road mishaps, ran off road accidents, and collisions with another vehicle than larger cars do.

Search terms: Illinois; Driver fatalities; Passenger fatalities; Age factor in accidents; Pedestrian fatalities; Accident statistics; Compact automobile accidents; Accident rates; Accidents by vehicle size; Bicycle accidents;

Rural accidents; Urban accidents; Accident types; Injury statistics

## **2/0 HIGHWAY SAFETY**

HS-009 585 Fld. 2/0

# **HIGHWAY SAFETY—A PROG- RESS REPORT**

by William Haddon, Jr.

Published in *Journal of the Medical Association of Georgia* v56 n11 p456-9 (Nov 1967)

Highway casualties in the United States total over 10,000 injuries daily, more than 1,000 deaths weekly, require 8 million days of hospitalization each year to treat survivors, and cost about \$1 billion each month. The precrash, crash, and postcrash phases of this national problem are discussed. The inadequacy of emergency medical services, the role of the secondary collision in causing injuries, and accident factors such as roadside hazards are discussed. The National Traffic and Motor Vehicle Safety Act and the Highway Safety Act established standards for dealing with highway safety problems.

Search terms: Precrash phase; Postcrash phase; Impact phase; Emergency medical services; Vehicle safety; Highway safety; Highway Safety Act of 1966; National Traffic and Motor Vehicle Safety Act of 1966; Secondary collisions; Safety standards; Roadside hazards

HS-009 586 Fld. 2/0

# **DEVELOPMENTS FOR HIGH- WAY SAFETY BY THE AUTOMO- BILE INDUSTRY**

by Harry A. Williams

Automobile Manufacturers Assoc., Inc.

1963 9p

Advance paper prepared for presen-



## 2/0 HIGHWAY SAFETY (Cont'd.)

### HS-009 586 (Cont'd.)

tation at Liberty Mutual's Council on the Automobile and Public Health, Panel 4, Boston, 22 Nov 1963.

The cooperation among the federal government, the Automobile Manufacturers Association, the Automotive Safety Foundation, the National Safety Council, the American Association of Motor Vehicle Administrators, industry, and independent research groups in improving highway safety is reviewed.

Search terms: Automotive industry; Safety organizations; Highway safety; Government industry cooperation; Highway safety programs

## 2/4 Design and Construction

### HS-009 587 Fld. 2/4; 4/8

**URBAN HIGHWAYS, PT. 2. HEARINGS ON URBAN HIGHWAY PLANNING, LOCATION, AND DESIGN, BEFORE THE SUBCOMMITTEE ON ROADS. MAY 1, 6, 7, 8, 27, AND 28, 1968**

Congress. Senate Public Works Com.

1968 449p

90th Congress, 2nd sess.

This report contains the transcript of testimony before the Senate Subcommittee on Roads on the planning, location, and design of highways in urban areas. It also contains a number of statements relating to urban highways, from various state, federal, and other public officials and private citizens.

Search terms: Highway planning; Urban planning; Interstate Highway System; State government; Local government; Federal control; Urban highways; Transportation planning; Freeway planning; Parkways; Landscape design; Land usage; Urban geography; Highway costs; Land acquisition

damage assessment; Inner city areas; Highway beautification

AVAILABILITY: GPO

### HS-009 588 Fld. 2/4

**SURVEY OF THE SKID RESISTANCE PROPERTIES OF ASPHALT SURFACINGS (TUTKIMUKSIA ASFALTTPAALLYSTEIDEN KITKAOMINAI-SUUKSISTA)**

by J. M. I. Hyypä

Finland Valtion Teknillinen Tutkimuslaitos.

1969 58p 14 refs  
Report no. Pub-141

Text also in Finnish.

A light trailer apparatus, constructed in accordance with the model developed by Road Research Laboratory, was used to measure the skid-resistance properties of asphalt surfacings. In all, the investigations related to 102 road sections, about 1000 km in total length. Road sections at least one year old were measured with regard to their skid-resistance properties, the effect of tire-tread pattern and studs upon the coefficient of friction, and the effect and significance of the wearing induced by sanding material and traffic upon the coefficient of friction. At speeds of 50, 70 and 90 k.p.h., mean skid-resistance values of asphalt concrete and gravel asphalt concrete are 0.58, 0.46 and 0.39 respectively. The values were somewhat higher on older surfacings. It was found that the tire-tread pattern, studding, and also the grain size of sanding material considerably affected the value of the coefficient of friction; it was also affected by the wear resulting from traffic.

Search terms: Pavement skid resistance; Coefficient of friction; Pavement damage; Tire studs; Pavement wear; Asphalt pavements; Tire tread patterns; Sanding; Tire pavement interface; Road surfaces

### HS-009 589 Fld. 2/4

**DEVELOPMENT OF AN ANALYTICAL APPROACH TO HIGHWAY BARRIER DESIGN EVALUATION**

Cornell Aeronautical Lab., Inc.

Apr 1963 301p 44 refs  
Contract HS-5464  
Report no. RR-63-2

The purpose of this investigation is to review the existing information, develop a rational method of evaluating barrier performance, and verify the predicted vehicle reaction with full scale tests. Mathematical models were developed to describe the relationship between applied horizontal load and lateral deflection for three general classes of highway barriers, and to predict vehicle trajectory. The models were verified through 7 full scale crash tests with barriers. It was concluded that the desirable features of highway barriers are: firmly attached rails which cause a vehicle to vault the barrier or roll over strong posts which may snag the vehicle and barrier rails which deform at the vehicle. Recommendations for improved barrier design are included.

Search terms: Reviews; Barrier design tests; Mathematical models; Barrier design; Computerized evaluation; Barrier impact forces; Guardrail design; Barrier tests; Guardrail impact tests; Deceleration tolerances; Loading tests; Vehicle trajectories; Median barriers

## 2/8 Police Traffic Services

### HS-009 590 Fld. 2/8; 4/1

**SPEED ENFORCEMENT METHODS AND PRACTICES**

by David K. Witheford

Eno Foundation for Transport.

1970 145p 59 refs



A survey of speed enforcement practices across the nation was made by sending a questionnaire to all state highway patrol agencies, to all cities over 50,000 population and 100 selected cities with a population between 25,000 and 50,000. Some toll road agencies and counties were also surveyed. A second questionnaire was sent to a select 100 recipients. This report analyzes the results of these questionnaires with respect to speed limits and types of limits; apprehension practices and enforcement; and suggests the need for greater uniformity. It notes the unanimity of police officials that voluntary compliance must be the goal. Finally, the report suggests that if no criminal relationship is attached to treatment of violators, the responsibility for handling them might well be transferred from the courts to administrative agencies. Copies of the questionnaires used and pertinent excerpts from the Uniform Vehicle Code are included in the appendixes, as well as reports on speed zoning and enforcement methods.

Search terms: Speed studies; Day vs night speeds; Speed limits; Minimum speed limits; Speed limit effectiveness; Arrests; Traffic ticket systems; Law uniformity; Uniform Vehicle Code; Radar; Traffic surveillance; Questionnaires; Traffic law enforcement; Police traffic services; Traffic law violators; Traffic courts; Speed recorders; Speed differentials

## 2/9 Traffic Control

HS-009 591 Fld. 2/9

### VARIATIONS OF LIGHT VEHICLE SPOT-SPEEDS

by B. E. Fernie

National Res. Inst. for Math. Sci. (South Africa)

Jun 1968 11p 4 refs  
Report no. RT/5/68

In order to evaluate the reliability of

comparative speed studies made in the past and to provide a factual basis for the planning of such studies in the future, it was necessary to find whether average spot-speeds of light motor vehicles remain essentially constant, either throughout the day or, for a given period of the day, from one day of the week to another. Spot-speeds of vehicles of this class were measured at a certain location over a period of two weeks to cover the hours 6 a.m. to 10 p.m. on each day of the week. Results were recorded separately for each two-hour period; in all, nearly 42,000 speeds were included in the sample. Average spot-speeds calculated from these data show significant inconsistencies during the day and through the days of the week. Consequently, subjective choices of the times and the days for measuring spot-speeds may lead to false conclusions concerning the means of such speeds.

Search terms: Speed studies; Speed patterns; Spot speed characteristics; Time of day; Day of week; Confidence intervals; Day vs night speeds

HS-009 592 Fld. 2/9

### HIGHWAY SPEED STUDY

Connecticut State Hwy. Dept.

Nov 1964 48p

Speeds were metered at thirteen locations on four general highway types. The average speed for all types of vehicles was 48.9 mph, an increase of 1.6 mph over November 1963. Speed patterns on four-lane undivided highways, four-lane divided highways with grade separations and with intersections at grade, and two-lane highways are analyzed. Speeds for male and female drivers with and without passengers are given.

Search terms: Connecticut; Speed studies; Speed patterns; Driver characteristics; Driver sex; Four lane highways; Divided highways; Two lane roads; Male drivers; Female drivers

HS-009 593 Fld. 2/9

### HIGHWAY SPEED STUDY

Connecticut State Hwy. Dept.

Aug 1969 54p

Speeds were metered at thirteen locations on four general highway types found throughout Connecticut. The average speed for all types of vehicles was 48.6 mph, 0.7 mph less than for August 1968. Speed patterns on four-lane undivided highways, four-lane divided highways with grade separations and with intersections at grade, and two-lane highways are analyzed. Speeds for male and female drivers with and without passengers are given.

Search terms: Connecticut; Speed studies; Speed patterns; Driver characteristics; Driver sex; Four lane highways; Male drivers; Female drivers; Divided highways; Two lane roads

HS-009 594 Fld. 2/9; 3/12

### FACTORS IN HIGHWAY SIGN VISIBILITY

by T. W. Forbes

Published in *Illuminating Engineering* v65 n8 p495-503 (Aug 1970)

12 refs

Reprinted from *Traffic Engineering*, Sep 1969.

The effectiveness of highway signs in terms of visibility is discussed. Results showed that brightness contrast factors were of greatest importance, and contrast of letter-to-sign and sign-to-background should be balanced for best visibility and effectiveness. Experiments also showed that signs located over the highway were more likely to be seen earlier than those to either side. Laboratory tests with simulated signs were compared with mathematical models. Estimates were made of the actual distances as which signs were seen under day and night conditions.

## 2/9 Traffic Control (Cont'd.)

### HS-009 594 (Cont'd.)

Search terms: Highway signs; Sign visibility; Brightness; Visual perception; Contrast; Sign lighting; Mathematical models; Laboratory tests; Reflectorized signs; Sight distances; Sign effectiveness; Sign location; Night visibility

## 2/10 Traffic Courts

### HS-009 595 Fld. 2/10

#### REVOLUTIONARY CHANGES NEEDED IN TRAFFIC LAW ENFORCEMENT

by Lyle H. Taux

Published in *Traffic Safety* v70 n7 p16-7 (Jul 1970)

The annual traffic accident toll in terms of lives lost, injuries, and costs in money is cited as proof that present traffic control methods are woefully inadequate. Problems stemming from the current approach are due to the necessity of handling minor traffic violations under criminal procedures, the use of license suspension or revocation as a penalty, and inconsistencies in fines levied for minor traffic offenses. Suggestions include display of driver's licenses on outside of the vehicle, classification of minor traffic offenses as civil misuse of highway, use of modern traffic violation detection devices that include cameras to provide photographic evidence of the traffic infraction, improved traffic citation forms fed to a statewide computer system and discontinuance of traffic court hearings for minor infractions.

Search terms: Traffic law enforcement; Traffic courts; Traffic law violations; Traffic ticket systems; Traffic law violators;

## 3/0 HUMAN FACTORS

### 3/1 Alcohol

#### HS-009 596 Fld. 3/1

#### DRUNK DRIVERS. WHAT MICHIGAN IS DOING ABOUT THEM

by William E. Barber

Published in *Police Chief* v37 n9 p42-6 (Sep 1970)

The implementation of Michigan's Implied Consent Law involved the evaluation and selection of alcohol breath testing equipment, the training and certification of police officers who would give the test, development of a maintenance and inspection program, periodic recertification of police officers, and cooperation of public information agencies throughout the state. Michigan officials recommend the breath test over either blood or urine testing, since it provides immediate results and frees the officer for further duty. Other recommendations include use of one kind of testing equipment only, statewide certification of trained operators, a statewide program of maintenance and inspection of equipment, and a continuing statewide-level evaluation of the conduct of the program.

Search terms: Drinking drivers; Alcohol breath tests; Breathalyzers; Michigan; Police training; Implied consent laws; Alcohol education; Driver intoxication

### 3/2 Anthropomorphic Data

#### HS-009 597 Fld. 3/2; 3/4

#### SEMINAR ON RESEARCH APPLICATIONS OF DRIVING SIMULATION, MARCH 18-22, 1963, COLUMBUS, OHIO. PROCEEDINGS

Ohio State Univ.

Sep 1963 93p 3 refs  
Report no. SC-25-1

Includes HS-009 599 - HS-009 602

Current trends in driving simulation are examined, with emphasis on laboratory study of the driver-vehicle-road complex. The three primary applications of driving simulation are: effective driver training; safety promotion; methods for establishing design criteria of the vehicle and roadway configuration.

Search terms: Driving simulation research; Human factors engineering; Man machine systems; Driver behavior research; Driving simulators; Driver vehicle road interfaces; Driver education; Highway safety; Safety design; Conferences

### 3/3 Cyclists

#### HS-009 598 Fld. 3/3

#### A STUDY OF CYCLISTS TURNING RIGHT

by A. Crawford

Published in *Occupational Psychology* v37 n4 p255-66 (1963)

A study has been made of the behavior of pedal cyclists turning right at intersections in Great Britain. The study was made at times and places where a high proportion of children could be observed. The data collected were not sufficient to examine the interaction of age and traffic conditions, but a long process of learning by experience appears to be reflected in the behavior, in the apparent association between the steps in the total behavior, and in the related accident data.

Search terms: Bicycle rider behavior; Bicycle rider age; Traffic signals; Traffic flow; Decision making; Bicycle accidents; Right turns

### 3/4 Driver Behavior

#### HS-009 599 Fld. 3/4

#### SIMULATION INVESTIGATION IN MAN-MACHINE ENVIRONMENT SYSTEMS: VARIABLES

AUGUST 27, 1971

HUMAN FACTORS

## AND CRITERION EVALUATION

by Edward R. Jones

McDonnell Douglas Corp.

Published in HS-009 597, *Seminar on Research Applications of Driving Simulation Proceedings*, Columbus, 1963 p21-8

Presented at the Seminar, Columbus, Ohio, 18-22 Mar 1963.

Simulators are powerful devices for research on driving behavior because control and manipulation of a range of variables is possible; measurement is possible, especially with computer techniques; the experimental situation can be defined quantitatively; and stratified samples of subjects can be used. It is recommended that the variables simulated should be driver and pedestrian characteristics; social situations; vehicle characteristics; and road characteristics. The ways in which the variables should be manipulated, the use of subjects to best advantage, and the criteria of system performance are discussed.

Search terms: Man machine systems; Driver vehicle road interfaces; Driver behavior research; Driving simulation; Driver characteristics; Pedestrian characteristics; Sociological factors; Vehicle characteristics; Variables

HS-009 600 Fld. 3/4

## AN APPROACH TO THE THEORY OF MEASURING DRIVER BEHAVIOR

by Bernard H. Fox

Public Health Service

Published in HS-009 597, *Seminar on Research Applications of Driving Simulation Proceedings*, Columbus, 1963 p35-42

3 refs

Presented at the Seminar, Columbus,

Ohio, 18-22 Mar 1963.

A number of driving simulators are described and an approach to their most effective use is proposed. It involves determining how a driver drives, what the outside influences on his driving are, what makes him drive the way he does, and how his driving habits can be improved. To accomplish this, it is necessary to establish driver profiles and relate them to the probability of certain types of accidents. Next, it is necessary to study the improvement possible in the driver.

Search terms: Driving simulators; Driver behavior research; Driver characteristics; Driver improvement; Driver performance; Driving task analysis; Accident risk forecasting

HS-009 601 Fld. 3/4

## A LOOK AT THE NATIONAL INTEREST IN DRIVING SIMULATION

by Robert F. Baker

Bureau of Public Roads

Published in HS-009 597, *Seminar on Research Applications of Driving Simulation Proceedings*, Columbus, 1963 p57-61

Presented at the Seminar, Columbus, Ohio, 18-22 Mar 1963.

Nearly all problems in the highway field which involve the human factor offer some potential for the use of simulation techniques. The research program of the Bureau of Public Roads is outlined. Driving simulation research is being applied to problems of urban traffic and highway safety.

Search terms: Driving simulation research; Highway safety; Traffic research

## 3/5 Driver Education

HS-009 602 Fld. 3/5

## RESEARCH APPLICATIONS OF DRIVING SIMULATION: TRAINING

by Kenneth F. Thomson

Naval Training Device Center

Published in HS-009 597, *Seminar on Research Applications of Driving Simulation Proceedings*, Columbus, 1963 p29-34

Presented at the Seminar, Columbus, Ohio, 18-22 Mar 1963.

The use of simulators for training demands a careful task analysis from the standpoint of the trainee as well as the trainer; a thoughtful choice of the means of simulation in terms of the strengths and weaknesses of the simulation method; a knowledge of the training environment; and, a consideration of the tradeoffs or compromises necessary to insure an economically successful simulator integration into the training regime. The processes and problems involved in learning with simulators are described.

Search terms: Driving simulation research; Learning rates; Simulators

HS-009 603 Fld. 3/5

## SAFETY TIPS FOR DEAF PEDESTRIANS AND DEAF DRIVERS

by Sherman G. Finesilver

Denver Driver Improvement School

28 Feb 1961 22p

All drivers, hearing and non-hearing, have a responsibility to keep pace with safe driving techniques brought about by advanced traffic engineering, super highways and higher cruising speeds. Modern driving also demands constant review of traffic laws and regulations. It should be observed that over 70% of all accidents "occur" under ideal traffic conditions

## 3/5 Driver Education (Cont'd.)

### HS-009 603 (Cont'd)

with excellent weather and moderate traffic. These accidents usually happen to so-called "good" drivers. This manual was prepared to assist deaf drivers in their safe driving habits and knowledge of traffic laws.

Search terms: Driver education manuals; Driver improvement; Deaf drivers; Pedestrian safety

### HS-009 604 Fld. 3/5

#### THE HIGHWAY JUNGLE: THE STORY OF THE PUBLIC SAFETY MOVEMENT AND OF THE FAILURE OF "DRIVER EDUCATION" IN THE PUBLIC SCHOOLS

by Edward A. Tenney

Published by Exposition Press, Inc., New York \$4.00

1962 174p 23 refs

Driver education as it is taught in our public schools is reviewed, and statistics are supplied to show that "driver education" does not reduce the number of highway accidents. The quality of textbooks and caliber of teaching are also examined. A distinction is made between "driver education" and "driver training." The history of the safety education movement and of safety propaganda are outlined, and driver education is seen as a branch of consumer education.

Search terms: Driver education; Adolescent drivers; Driver attitudes; Instruction materials; Instructors; Driver education standards; Driver education laws; Safety education; Safety propaganda; Driver education evaluation; Psychological factors; High school driving courses; Accident rates; History

### HS-009 605 Fld. 3/5

#### DEVELOPING RESPONSIBLE DRIVERS. A MANUAL ON DRIVER EDUCATION

by Marguerite R. Juchem

Colorado Dept. of Education

1962 66p refs

A suggested course of study for high school driver education classes in Colorado is outlined. A method of organizing and administering a driver education program is presented, and lesson plans for classroom activities and practice driving are provided. A special section of the report describes special teaching aids available for driver education courses. An appendix provides suggested class schedules and samples of various report and record forms for use with the class, as well as a list of information sources, publications, and training films.

Search terms: Colorado; Driver education; Classroom driver instruction; Behind the wheel instruction; High school driving courses; Driver education manuals; Instruction materials

### HS-009 606 Fld. 3/5

#### DRIVER ENGINEERING: ALL STATE'S FLEET SAFETY PROGRAM

by Spencer McAllister

Published in *Automotive Fleet* v9 n11 p26-8 (Sep 1970)

The fleet crash prevention program Allstate Insurance Company requires all new company-car drivers to take is described. Emphasis is placed on defensive driving, development of better perceptual skills, and on tailoring the course to the crash records of the particular employees in any given class. Of 350 drivers who have taken this course, all but one have improved their crash records. Companywide there has been a

76% improvement in crash-ratio between drivers who have taken the course and those who haven't.

Search terms: Fleet safety; Defensive driving; Driver skills; Perception; Driver performance; Fleet driver training; Driver records; Safety program effectiveness

## 3/6 Driver Licensing

### HS-009 607 Fld. 3/6

#### A REPORT DEVELOPING A COMPREHENSIVE STATE PROGRAM OF MOTORCYCLE DRIVER'S LICENSING

by LeGrand L. Malany

Illinois Univ. Hwy. Traf. Safety Center

Aug 1969 128p

Report no. RR-3

This report describes the development of a comprehensive program of licensing motorcycle drivers developed by the State of Illinois. The report is divided into six major parts. Part one describes the objectives and basic design of the licensing program. Part two discusses the written and physical examinations and presents a model written license exam. Parts three and four present the materials needed to establish the skill and road tests, including grading forms and criteria. Parts five and six consist of committee recommendations, suggested areas of future research, and a series of appendices which are concerned with such topics as road test course diagrams of each of the state examination stations, course outlines for license examiner workshops, and other germane supplementary materials.

Search terms: Driver performance; Driver physical fitness; Driver skills; Motorcycle riding techniques; Road tests; Illinois; Motorcycle operator licensing; Driver license examination; Driver tests

AUGUST 27, 1971

HS-009 608 Fld. 3/6

# PERIODIC PHYSICAL RE-EXAMINATION OF MOTOR VEHICLE OPERATORS. AN EVALUATION OF THE PENNSYLVANIA EXPERIENCE

Pennsylvania Joint State Government Commission

1963 24p

The Pennsylvania Bureau of Traffic Safety's experience with periodic physical reexamination of motor vehicle operators is reported. Reasons for not responding to call, numbers who voluntarily surrendered their licenses, distribution of reasons for rejection of drivers, and cost of examinations are discussed. Based on the projected accident record of drivers tested and rejected for further licensing, the State of Pennsylvania has concluded that periodic reexamination of all drivers in the state is unrealistic in terms of cost and effectiveness in identifying drivers whose physical or mental condition might cause an accident. A statistical summary of Pennsylvania motor vehicle accidents for 1961 is provided in the appendix.

Search terms: Driver physical examinations; Pennsylvania; Accident statistics; Driver physical fitness; Driver disqualification; Driver license revocation; Driver mental fitness; Vision disorders; Driver reexamination; Fatality statistics; Driver license cancellation; Accident risks

## 3/12 Vision

HS-009 609 Fld. 3/12

# DEVELOPMENT OF VAN DRIVER EYE ELLIPSES

by J. D. Hromi; J. Versace; C. O. Smith

Ford Motor Co.; Detroit Univ.

1971 31p 28 refs  
Report no. SAE-710541

Presented at Society of Automotive Engineers mid-year meeting, Montreal, 7-11 Jun 1971.

This study was undertaken to determine to what extent the passenger car eye ellipses have applicability in van-type truck package design and to produce a new practical design tool, if necessary. Eye positions of van drivers were found to be distributed differently from those for passenger car drivers and from those obtained by the procedure outlined in SAE J941b, Motor Vehicle Driver's Eye Range. Tables of parameter values were produced, suitable for a van-package designer to use readily to position eye-location distributions in space as a function of the azimuth and elevation angles of many targets in the forward field of view.

Search terms: Eyellipse; Visibility; Truck design; Field of view; Eye location; Mathematical models; Truck drivers; Human body simulation

AVAILABILITY: SAE

HS-009 610 Fld. 3/12; 3/6; 3/9

# PREPARING THE VISUALLY HANDICAPPED PERSON FOR MOTOR VEHICLE OPERATION

by Donald R. Korb

Published in *American Journal of Optometry and Archives of American Academy of Optometry* v47 n8 p619-28 (Aug 1970)

28 refs

A bioptic telescopic lens system which can enable a visually handicapped person to satisfy the visual acuity requirements for licensure for motor vehicle operation is described. The system is composed of two parts: the usual lens correction and a compact telescopic prescription unit incorporating correction for the refractive error of the subject. Alignment of the telescopic portion and the problems involved in getting accustomed to such a device are discussed. Of thirty-two per-

## OTHER SAFETY RELATED AREAS

sons who were fitted with telescopic lenses, twenty have passed the visual requirements and a road competency test and were issued licenses in Massachusetts. Six have been licensed in other states or Canada. At the writing of this paper, all 26 had unblemished safety records. Recommended criteria for licensure of the visually handicapped are provided.

Search terms: Telescopic systems; Driver vision standards; Handicapped drivers; Vision disorders; Eyeglasses; Driver license standards; Visual acuity

HS-009 611 Fld. 3/12

# DANGER: NIGHT DRIVING AHEAD

by Harris Edward Dark

Published in *Today's Health* v40 n11 p23, 54-6 (Nov 1962)

The decrease in visual efficiency for night driving is discussed. Included are problems caused by glare, dirty windshields and headlights, driver fatigue, age, alcohol, tobacco, exposure to excessive sunlight, and carbon monoxide. The dangers of falling asleep at the wheel, wearing tinted glasses at night, and driving too fast at night are also discussed.

Search terms: Night vision; Night driving; Sleep; Driver fatigue; Attention lapses; Twilight vision; Reduced visibility; Carbon monoxide; Headlamp glare; Headlamps; Driver physical fitness; Windshield dirt accumulation; Sunglasses; Vision age changes; Drinking drivers; Smoking

## 4/0 OTHER SAFETY-RELATED AREAS

### 4/1 Codes and Laws

HS-009 612 Fld. 4/1; 5/0

# FEDERAL CONSUMER SAFETY LEGISLATION. A STUDY OF THE SCOPE AND ADEQUACY OF THE AUTOMOBILE SAFETY,

**4/1 Codes and Laws (Cont'd.)**

**HS-009 612 (Cont'd.)**

**FLAMMABLE FABRICS, TOYS, AND HAZARDOUS SUBSTANCES PROGRAMS**

by Howard A. Heffron; Richard J. Medalie; Stephan Kurzman; Marian R. Pearlman

Jun 1970 228p refs

A special report prepared for the National Commission on Product Safety.

This report is a study of Federal laws covering safety requirements for automobiles, flammable fabrics, hazardous substances, and toys, and how the regulations have actually worked. Included in the study are the National Traffic and Motor Vehicle Safety Act, the Flammable Fabrics Act, and the Federal Hazardous Substances Act. The section on vehicle safety includes discussion of safety standards; the rulemaking process; the impact of standards on reduction of deaths and injuries; tire standards; compliance testing and defects review; defect notification and recalls; standards enforcement.

Search terms: National Traffic and Motor Vehicle Safety Act of 1966; Safety standards; Safety standards compliance; Tire standards; Rule making; Defective vehicles; Recall campaigns; Flammability; Defective tires; Federal laws; Consumer protection; Hazardous materials; Defective products; Product safety; Defects

AVAILABILITY: GPO \$1.25

**HS-009 613 Fld. 4/1; 5/2**

**STATE LAWS GOVERNING STOPPING FOR SCHOOL BUSES**

National Hwy. Users Conference

Sep 1963 9p

Motor vehicle laws digest series

Laws requiring drivers on open highways to stop and remain stopped for a school bus picking up or discharging school children have been reviewed for uniformity and conformity with the Uniform Vehicle Code. Laws of all fifty states and the District of Columbia were included. All but four jurisdictions were in either general or substantial conformity with the code. Those not in agreement were the District of Columbia, four counties in Hawaii, Oklahoma, and Texas.

Search terms: School buses; Uniform Vehicle Code; School bus overtaking regulations; State laws; Law uniformity

**HS-009 614 Fld. 4/1; 1/3**

**LEGAL ASPECTS OF SKID-MARKS IN TRAFFIC CASES. PT. 2**

by Richard A. Rifas

Published in *Traffic Digest and Review* v18 n8 p18-24 (Aug 1970)

refs

The qualifications for giving an expert opinion on skidmarks and their indication of speed are discussed. A number of cases are cited and the weight or admissibility of evidence of each is explained. The use of charts or nomographs as aids in making a determination, the limitations placed on expert testimony, and the acceptability of lay testimony are also explained.

Search terms: Speed estimation from skidmarks; Witnesses; Trials; Testimony importance; Skidmarks; Accident reconstruction; Court decisions; Legal factors; Nomographs; Evidence

**4/2 Community Support**

**HS-009 615 Fld. 4/2**

**THE SAFETY BUG AND HOW IT GREW**

Anonymous

Published in *Highway User* p18-20 (Sep 1970)

The "Safety Bug" club is a fast-growing nationwide group of young children pledged to observe safety practices in and out of automobiles and traffic. "Safety Bug" materials include suggested safety projects, radio-TV announcements, news releases, a simple classroom skit, and letters of welcome for new members. Members of the club also pledge to "bug" others to observe safety practices as well.

Search terms: Safety campaigns; Child safety education; Mass media; Safety propaganda

**HS-009 616 Fld. 4/2**

**STANLEY THE FRIENDLY SCHOOL BUS IS A CHILD WATCHER**

Anonymous.

Published in *School Bus Fleet* v15 n4 p16-9 (Aug-Sep 1970)

A "Stanley, the Friendly School Bus" coloring book is being distributed to New Jersey schools on a cost basis, as a means of teaching bus safety to elementary school children who ride school buses. Particular emphasis has been placed on safety outside the vehicle. Membership cards in a "Stanley" club, membership pins, and a bicycle sticker reminding children to "Play Safe with Stanley" are also available.

Search terms: Safety campaigns; Safety propaganda; School bus safety; Child safety education

**5/0 VEHICLE SAFETY**

**HS-009 617 Fld. 5/0; 4/4**

**THE ROLES OF GENERAL SERVICES ADMINISTRATION AND DEPARTMENT OF TRANSPORTATION**

# **TATION IN MOTOR VEHICLE SAFETY STANDARDS. SPECIAL STUDY**

National Transp. Safety Board

5 Jun 1970 29p 9 refs

This study explores a way for the General Services Administration and the Department of Transportation to coordinate a program to provide more effective leadership in vehicle safety and assist both agencies in carrying out related missions. Under such a program, GSA would promulgate advanced safety standards for vehicles purchased by the Federal Government. Such standards would be higher than those now prescribed by DOT for all vehicles and would employ the full features of commercial standards, including labels and grades. GSA and DOT would cooperate in the development of the standards, and use GSA's practical experience in applying these standards to all vehicles. These commercial standards could also be used in grading and labeling vehicles for DOT's consumer information program.

Search terms: National Traffic and Motor Vehicle Safety Act of 1966; Vehicle safety standards; Consumer education; Government vehicles; Federal control; United States Government; Labeling

AVAILABILITY: NTIS \$3.00

## **5/1 Brake Systems**

HS-009 618 Fld. 5/1

### **FOUNDATION AIR BRAKE PERFORMANCE AT LOW OPERATING PRESSURES**

by R. R. Svenson

North American Rockwell Corp.

1970 6p

Report no. SAE-700513

Presented at SAE mid-year meeting, Detroit, 18-22 May 1970.

Truck air brake performance at low operating pressures is important to the owner because it represents the service range representative of the greatest amount of use. This paper presents the factors involved and the results to be expected from the most commonly used brakes on line haul trucks in current use. Included are representative input-output curves of the brakes. From a safety standpoint maximum performance at rated load is of paramount importance but service life is determined by balance at low operating pressures.

Search terms: Air brakes; Brake performance; Brake systems; Truck brakes; Brake balancing; Operating pressure

HS-009 619 Fld. 5/1

### **EMERGENCY-PARKING BRAKE SYSTEM FOR LARGE WHEEL LOADERS AND DOZERS**

by Thomas E. Cochran

Caterpillar Tractor Co.

1971 11p

Report no. SAE-710529

Presented at Earthmoving Industry Conference, Central Ill. Section, Peoria, 5-7 Apr 1971.

Caterpillar Tractor Co. has introduced a new emergency-parking brake system for its line of large wheel loaders and wheel type tractors. This system includes a multidisk spring-applied/hydraulically released emergency parking brake, a hydraulic control system providing both automatic and manual application of the brake, and an audiovisual warning system for the operator. The brake is for use on vehicles in the 60,000-140,000 lb range and is designed specifically to provide automatic application of the emergency-parking brake in the event of a loss of service brakes.

Search terms: Construction vehicles; Brake systems; Brake system design; Emergency brakes; Hydraulic brakes;

Disc brakes; Spring brakes; Brake performance; Parking brakes; Tractors; Warning systems

AVAILABILITY: SAE

HS-009 620 Fld. 5/1; 5/20; 5/11

### **6 SERVICE CHECKS ON BIG TRUCK BRAKES**

Anonymous

Published in *Motor* (New York) v134 n2 p37-9 (Aug 1970)

A simple checkout procedure for servicing truck brakes is outlined. A typical truck-trailer air brake system schematic is supplied. Exceptions to the rule for the various check points are also listed.

Search terms: Air brakes; Brake inspection; Brake maintenance; Truck brakes; Truck emergency brakes

HS-009 621 Fld. 5/1; 5/20

### **ROCKWELL STANDARD'S ANTI-SKID BRAKE SYSTEM**

by Jake Lyndall

Published in *Fleet Owner* v65 n8 p155-7 (Aug 1970)

A simplified electronic anti-skid braking system for air-braked combinations has been developed. It not only eliminates uncontrolled skidding but will provide and maintain optimum braking forces between the tires and the road surface. During braking, when the system determines that any set of wheels are decreasing in speed too fast in relation to the reference wheel, it reduces the air pressure just enough to let the wheels pick up speed until they reach an acceptable ratio with the reference wheel. This is repeated whenever necessary. A dash-mounted release valve is available for tractors with front wheel brakes. The system is compatible with all air brake systems. Road tests on slick wet concrete have shown this system can bring a



## 5/1 Brake Systems (Cont'd.)

### HS-009 621 (Cont'd.)

tractor trailer to a complete stop with little deviation from a straight line course.

Search terms: Brake tests; Braking; Antiskid devices; Truck brakes; Air brakes; Wheel speed capability; Tractor trailers

## 5/2 Buses, School Buses, and Multipurpose Passenger Vehicles

### HS-009 622 Fld. 5/2; 5/15

#### HYBRID DIESEL-ELECTRIC BUS MAY HELP CITIES TO LICK NOISE-AIR-POLLUTION PROBLEMS

Anonymous

Published in *Automotive Engineering* v78 n8 p42-5 (Aug 1970)

A hybrid diesel-electric bus is being developed by Daimler-Benz to provide quiet, exhaust-free operation in inner-city traffic. The Mercedes-Benz OE 302 research vehicle, as it is called, has an electric drive unit, with electronic control. For city operation, power is provided by batteries. When the bus is outside the city center, a diesel-generator unit produces the power to operate the traction motor. The excess power is fed to the batteries.

Search terms: Hybrid buses; Diesel engines; Batteries; Electric buses

## 5/4 Design

### HS-009 623 Fld. 5/4

#### AUTOMOTIVE FORGINGS—POWDER LEADS TO HIGHER PRECISION

by M. P. Jarrett; P. K. Jones

G. K. N. Forgings and Castings Ltd.

1971 9p

Report no. SAE-710119

Presented at Automotive Engineering Congress, Detroit, 11-15 Jan 1971.

The consistent quality and good mechanical properties of hot forgings have been used to advantage by designers for many years. Forging developments giving improved material utilization and closer dimensional tolerance are successful for specific applications. A new process, powder forging, has the potential to provide precision forgings for a wide variety of components. Combining the advantages of conventional powder metallurgy with those of hot forging, it produces forgings of close tolerance and fine detail with properties comparable to wrought material. The process gives scope for the reduction or elimination of machining, and already a variety of components have been made and successfully tested.

Search terms: Forgings; Powder metals; Performance characteristics

AVAILABILITY: SAE

### HS-009 624 Fld. 5/4; 4/7

#### AN ANALYSIS OF BODY STRUCTURES. PT. 2

by K. Kirioka; Y. Ohkubo; Y. Hotta

Toyo Kogyo Co. Ltd.

1971 12p 12 refs

Report no. SAE-710157

Presented at Automotive Engineering Congress, Detroit, 11-14 Jan 1971.

In this paper the matrix displacement method is employed in analyzing car body structures. The finite element method treats the car body as an arbitrary shell, whereby idealization of the car body structure becomes possible. The paper takes into consideration not only the plane stress, but also the bend-

ing stress. The program details which include an automatic input and output are described. The first calculation example shows a comparison between classic and present analyses of plates and shells, demonstrating the accuracy of this method. The next example shows an application to the whole and local structures of an actual car, a technique which makes possible reasonable body design analysis.

Search terms: Structural analysis; Automobile bodies; Finite element method; Stress analysis; Bending; Computerized simulation; Matrix reduction

AVAILABILITY: SAE

### HS-009 625 Fld. 5/4; 4/7

#### A MATHEMATICAL MODEL OF THE CHRYSLER HYGE IMPACT SIMULATOR

by S. L. Milan; R. W. Hegel

Chrysler Corp.; Monroe Auto Equipment Co.

1971 8p 10 refs

Report no. SAE-710167

Present at Automotive Engineering Congress, Detroit, 11-15 Jan 1971.

The Chrysler Hyge impact simulator permits full-scale laboratory simulation of the deceleration experienced by an automobile passenger compartment during impact. The need to duplicate a great variety of deceleration pulse shapes necessitates a large number of operating parameters. Unfortunately, this large number of parameters precludes easy determination of the relationships between parameter selections and desired pulse shapes. This paper describes the development of a mathematical model and digital computer program used by the Chrysler Engineering Office to predict the response of the impact simulator for a given set of parameters. The principal elements of the model deal with unsteady compressible gas flow and the effect of the resulting forces on the sled motion. The modeling of the metering

pin is of particular importance, since the characteristic shape of the acceleration pulse is limited by the pin contour. With the aid of this model it is possible to specify the complete set of operating parameters needed to simulate a desired pulse shape. This eliminates the need for costly, time-consuming, cut-and-try experimentation.

Search terms: Computerized simulation; Accident simulation; Mathematical models; Acceleration pulses; Deceleration; Passenger compartments; Compressed gases; Flow; Parameters; Deceleration tests; Pulse frequency; Impact forces; Simulation models

AVAILABILITY: SAE

HS-009 626 Fld. 5/4

#### VEHICLE IMPACT ANALYSIS

by F. F. Timpner

General Motors Corp.

1971 7p  
Report no. SAE-710540

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

This paper shows how to evaluate the impact between two different size vehicles with different energy-absorbing bumper systems. A pendulum will correlate with a barrier for head-on impacts, but not for corner impacts.

Search terms: Impact tests; Energy absorbing bumpers; Impact forces; Impact attenuation; Impact angle; Barrier impact forces; Vehicle vehicle collisions; Pendulum tests; Energy absorption; Barrier collision tests; Mathematical analysis; Head on collisions

AVAILABILITY: SAE

HS-009 627 Fld. 5/4; 4/7

#### FOURIER CAM DESIGN TECHNIQUES

by Jerry L. Hardiman; Frank H. Speckhart

Bell Telephone Labs.; Tennessee Univ.

1971 6p 10 refs  
Report no. SAE-710544

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

A digital computer method employing Fourier series and transfer function notation is presented for calculating a cam profile that will give a desired output motion of a flexible system. The system model must be linear but can have essentially any number of degrees-of-freedom, and damping at any point in the system is permitted. It is also possible to specify the best cam profile of a system running in a given speed range. Forces at any point in the system can be calculated by the method, and accurate predictions of jump can be made.

Search terms: Fourier analysis; Mathematical models; Computerized simulation; Cams; Computerized design; Degrees of freedom; Damping

AVAILABILITY: SAE

HS-009 628 Fld. 5/4

#### APPLICATION OF THE HYDRAULIC SHOCK ABSORBER TO A VEHICLE CRASH PROTECTION SYSTEM

by Douglas P. Taylor

Tayco Developments, Inc.

1971 13p  
Report no. SAE-710537

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

Energy absorbing crash protection systems are now being developed using various types of shock absorbing devices. This paper deals with design parameters involved in producing such a system. Basic shock absorber concepts as applied

to this problem are treated in general discussion centering on hydraulic devices. Governing equations are presented dealing with the design of a hybrid device combining a shock absorber and a compressible medium return mechanism capable of being used as a 5mph zero damage bumper system for a passenger car.

Search terms: Shock absorbers; Hydraulic bumpers; Energy absorbing bumpers; Energy absorbing systems; Impact forces; Impact tolerances

AVAILABILITY: SAE

HS-009 629 Fld. 5/4

#### DEVELOPMENT WORK ON THE MERCEDES-BENZ COMMERCIAL DIESEL ENGINE "MODEL SERIES 400"

by Heinz Hoffman

Daimler-Benz A.G. (West Germany)

1971 14p  
Report no. SAE-710558

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971

The development and testing of the new series of Mercedes-Benz diesel engines, the Model Series 400, is discussed in this paper. The series includes 6-, 8-, 10-, and 12-cyl V-engines and 5- and 6-cyl in-line engines. All feature a 4.922 in. bore and 5.117 in. stroke, a piston displacement of 97.4 cu in. per cylinder, water cooling, and direct fuel injection. Specific items covered are the combustion system, ignition, emissions, pistons, cylinder head gaskets, and the cooling system.

Search terms: Diesel engines; Fuel injection; Ignition delay; Diesel engine exhaust emissions; Pistons; Gaskets; Cooling systems; Precombustion chamber engines; Heavy duty vehicles; Valves

AVAILABILITY: SAE

**HS-009 630** Fld. 5/4; 3/4

## EXPERIMENTAL SAFETY CARS COPE WITH DRIVER FAILURE

by Frank J. Crandell

Liberty Mutual Insurance Co.

1963 10p

Prepared for presentation at Liberty Mutual's Council on the Automobile and Public Health, Panel 3, Boston, 21 Nov 1963.

An experimental safety car that will protect both passengers and driver is described. The car is designed to protect the driver and front-seat passenger in a 30 mph collision against a 5,000 lb blow and deceleration force of 30 g's. A point-light-source simulator, used to study driver reactions, is also described. It is a non-programmed simulator which can be driven in any direction at any speed the driver chooses, and his reactions are recorded for future evaluation.

Search terms: Safety cars; Injury prevention; Interior design; Impact protection; Driving simulators; Safety design; Crashworthiness; Occupant protection; Driver behavior

**HS-009 631** Fld. 5/4; 3/4; 3/5

## AUTOMOBILE DRIVING SIMULATOR TEST MODEL

Goodyear Aircraft Corp.

9 Apr 1963 69p  
Report no. GAP-2005

An automobile driving simulator test model is proposed which would be a nonprogrammed visual display device, capable of presenting a driving environment under various levels of illumination on a high gain projection screen located in front of an actual automobile for viewing by the subject driver. The display will also be presented on a television screen for use by the equipment operator, and will respond to automobile

controls in a manner representative of the actual visual cues associated with the driving task. This report also contains information relative to the personnel, plant facilities, and equipment which would be involved in the proposed program.

Search terms: Driving simulators; Driver education; Closed circuit television; Driving simulation

**HS-009 632** Fld. 5/4; 5/14

## DESIGN ASPECTS OF AUTOMOBILE SAFETY

by Alex L. Haynes

Ford Motor Co.

1963 23p 13 refs

Prepared for presentation at Liberty Mutual's Council on the Automobile and Public Health, Panel 3, Boston, 21 Nov 1963.

The development of safety engineering practices in the automobile industry from 1952 until 1963 is reviewed. The safety components thus developed and incorporated in passenger cars as of the date of this paper include seat belts and harness, padded instrument panels, crashworthy door latches and energy absorbing steering wheels. Full-scale and computerized crash tests are also discussed.

Search terms: Safety engineering; Safety design; Seat belts; Shoulder harnesses; Instrument panel padding; Door latches; Computerized simulation; Crashworthiness; Impact tests; Energy absorbing steering columns; Automobile design; Energy absorbing instrument panels

## 5/6 Fuel Systems

**HS-009 633** Fld. 5/6

## A STATEMENT ON PENDING SENATE CHANGES TO THE

## CLEAN AIR ACT

by L. A. Iacocca

Ford Motor Co.

Reprinted from *Automotive News* n4299 (21 Sep 1970).

Proposed Senate changes to the Clean Air Act could prevent continued production of automobiles or lead to huge price increases after January 1, 1975. The economic importance of the automobile industry is discussed. Emissions of hydrocarbons, carbon monoxide, oxides of nitrogen, and particulates are discussed in regard to standards, lead time, and warranties.

Search terms: Hydrocarbons; Carbon monoxide; Nitrogen oxides; Exhaust emission standards; Exhaust emission control devices; Lead time; Automotive industry; Air pollution laws; Economic factors; Automobile prices; Particulate air pollutants; Warranties

**HS-009 634** Fld. 5/6; 5/11

## URBAN TRANSPORTATION AND EMISSIONS

by H. Chaput

Ottawa Transp. Commission (Canada)

1971 15p 8 refs  
Report no. SAE-710559

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

This paper describes techniques and other significant factors to satisfy good maintenance, consistent with the control and abatement of diesel exhaust emissions in urban transit operations. Major stress is placed on the use of instruments, not only for inspection, diagnosing, and correcting obvious faults which cause black and blue smoke, but also for monitoring engine deterioration and indicating when motor and torque oil should be changed. Engine wear is cited as the major enemy to both engine life

and control of less obvious yet more troublesome emissions, and fuel dilution and dirty engine conditions as major causes of wear. The use of new devices to reduce fumes and an approach to engine and component replacement for an optimum balance between long life and good performance are described.

Search terms: Bus maintenance; Bus inspection; Vertical exhaust systems; Smoke meters; Diesel engine exhaust emissions; Engine operating conditions; Exhaust emission control

AVAILABILITY: SAE

#### HS-009 635 Fld. 5/6

### THE EFFECT OF TEMPERATURE VARIATIONS IN THE ENGINE COMBUSTION CHAMBER ON FORMATION AND EMISSION OF NITROGEN OXIDES

by L. J. Muzio; E. S. Starkman; L. S. Caretto

Columbia Univ.; California Univ., Berkeley; Imperial Coll. of Science and Technology (England)

1971 12p 17 refs  
Grant AP-385; AP-39, 220-02  
Report no. SAE-710158

Presented at Automotive Engineering Congress, Detroit, 11-15 Jan 1971.

Temperature variation in the combustion chamber of spark ignition engines is a vital factor in determining exhaust pollutant concentrations. Oxides of nitrogen are particularly affected. The temperature and concentration variations were investigated both theoretically and experimentally. A nonuniform model of the combustion process was developed. Calculations based on this model show that a temperature difference of the order of 600 K can be established across the cylinder. The validity of this model was substantiated by results of infrared spectroscopic measurements in the operating engine

cylinder. The kinetic mechanism for formation of nitric oxide was used, along with the nonuniform combustion model, to investigate the formation of nitric oxide in the cylinder. Results of the kinetic calculation show that the temperature gradient across the cylinder has a profound effect on the nitric oxide formation. The calculations are shown to be in agreement with results of direct cylinder sampling for a variety of engine variables including fuel-air ratio, spark timing, and engine speed.

Search terms: Combustion chambers; Spark ignition engines; Exhaust densities; Mathematical models; Thermal kinetics; Thermodynamic properties; Air fuel ratio; Spark timing; Engine speeds; Combustion rate; Nitrogen oxides; Ignition temperature; Engine operating conditions; Cylinder gases; Flame propagation

AVAILABILITY: SAE

#### HS-009 636 Fld. 5/6

### AIR POLLUTION FROM ROAD TRAFFIC - A REVIEW OF THE PRESENT POSITION

by P. T. Sherwood; P. H. Bowers

England Road Research Lab.

1970 33p 28 refs  
Report no. RRL-LR-352

This report reviews the present position about air pollution from road traffic with particular reference to conditions in Great Britain, to provide a basis for assessing needs for further research into the problem. Pollution from traffic is small compared with other sources of pollution and there is no evidence that the pollutants emitted by traffic have any permanent effects on health. There may, however, be temporary effects that affect behavior and there is no doubt that smoke and smell from traffic are unpleasant. It is recommended that consideration should be given to these two aspects to find the extent of the problem so that the value of emission controls

can be assessed. The report also discusses methods of reducing emissions from road vehicles and the legislation for controlling emissions in force in other countries. If controls of invisible emissions are introduced in Great Britain it will be necessary to establish whether the legislation is having any effect. There will therefore be a need for a rapid method of assessing whether a vehicle complies with the law and for monitoring the levels of pollutants in the air.

Search terms: Great Britain; Air pollution; Air pollution sources; Air pollution effect on health; Smoke; Exhaust odors; Exhaust emissions; Unburned fuels; Carbon monoxide; Air pollution in tunnels; Tunnel ventilation; Vehicle air pollution; Carboxyhemoglobin; Nitrogen oxides; Lead; Diesel engine exhaust emissions; Emission standards; Air pollution laws; Exhaust emission control; Air pollution emission factors

#### HS-009 637 Fld. 5/6

### EFFECT OF LEAD DEPOSITS ON ACTIVITY OF AUTOMOTIVE EXHAUST CATALYSTS

by L. J. E. Hofer; J. F. Schultz; J. J. Feenan

Bureau of Mines

1963 27p  
Contract no. RI-6243

This study was conducted to determine the nature and extent of the poisoning of catalysts when used to remove certain air pollutants from exhaust gases. The poisoning examined occurs when leaded gasoline is used as a fuel for automotive engines. To prevent the escape of hydrocarbons into the atmosphere, catalytic mufflers have been proposed. The catalysts are severely affected by the particulate matter, particularly the lead compounds contained in the exhaust gas. The catalytic method of oxidation of automobile exhaust has advantages over noncatalytic methods, but a disadvantage is the tendency of catalysts to

## 5/6 Fuel Systems (Cont'd.)

### HS-009 637 (Cont'd.)

become poisoned by substances in the automobile exhaust.

Search terms: Exhaust gases; Catalysts; Hydrocarbons; Leaded gasoline; Lead poisoning; Air pollutants; Catalytic converters; Exhaust emissions reactivity; Chemical reactions; Oxidation; Mufflers; Particulate air pollutants; Engine deposits

### HS-009 638 Fld. 5/6

#### POLLUTION

by E. S. Forest

Published in *Commercial Car Journal* v120 n1 p85-96 (Sep 1970)

The efforts being made by government and industry to reduce air pollution are discussed and compared. The gasoline engine is pinpointed as the major source of vehicle emissions although the diesel engine gets most of the blame in the public's view. Steps already being taken to reduce emissions and proposed future restrictions on these emissions are listed. Faced with the alternatives of cleaning up the internal combustion engine or developing an alternate power source, the industry has chosen to try to clean up the internal combustion engine, believing it to be the quicker answer. The development of the catalytic muffler and thermal reactor as possible solutions has increased interest in lead-free gasoline, since neither of these devices will operate long on leaded gasoline. Steps that can be taken by diesel fleetmen to convince the public that diesel engines are not a prime cause of vehicle pollution are suggested.

Search terms: Exhaust emission control; Diesel engine exhaust emissions; Exhaust emission standards; Exhaust emission control devices; Lead free gasoline; Catalytic converters; Thermal reactors; Internal combustion engines; Air pollution emission factors

### HS-009 639 Fld. 5/6; 5/21

#### USED CAR CONTROLS HALVE EMISSIONS

Anonymous

Published in *Automotive Engineering* v78 n8 p36-7 (Aug 1970)

Retrofit emission control kits are meant for use on automobiles built before 1966, which have no emission controls. The effects of these kits on cold start and hot cycle emissions are described. Vehicle driveability is affected. Both the GM system and a similar Ford system are based on the elimination of ignition vacuum advance during normal operation. Chrysler fits a special control valve to adjust vacuum advance selectively.

Search terms: Hydrocarbons; Nitrogen oxides; Coldstarts; Hotstarts; Used automobiles; Exhaust emission control devices; Driveability

### HS-009 640 Fld. 5/6

#### EUROPE STUDYING LEAD-FREE GASOLINE

Anonymous

Published in *Automotive Industries* v143 n3 p33-5 (1 Aug 1970)

Because there is no photochemical smog problem in Europe, there seems to be no reason why lead-free gasoline should be adopted there. But unless European car exports should cease, European automobile manufacturers will have to develop vehicles capable of running on unleaded gas. Two European oil companies have indicated they can supply unleaded fuel at about a 3% price increase, but with high compression ratios; this means an increase in fuel consumption of about 40%. This is not economically feasible in Europe where gasoline already costs about \$.70 per gallon. The whole problem of exhaust emissions is being studied in Europe, and developments in several countries are outlined.

Search terms: Lead free gasoline; Exhaust emissions; Europe; Compression ratio; Exhaust emission control; European vehicles; Gasoline consumption; Fuel costs

### HS-009 641 Fld. 5/6; 5/1

#### ASBESTOS AS A MODERN URBAN HAZARD

by J. G. Thomson; R. O. C. Kaschula; R. R. MacDonald

Published in *South African Medical Journal* v37 p77-81 (19 Jan 1963)

3 refs

In smears from lung bases from 500 consecutive autopsies in subjects of 15 years or over, asbestos bodies were found in 30% of the males and 20% of the females. In most cases this would appear to be the result of contamination of the urban atmosphere, and the bodies were scanty and not associated with pulmonary changes. An increase in the amount of urban air contamination would seem inevitable in view of the increasing consumption and diversity of uses of asbestos and of its virtual indestructibility. The use of asbestos in brake linings is briefly mentioned.

Search terms: Asbestos; Brake linings; Air pollution effect on health; Autopsies

### HS-009 642 Fld. 5/6

#### NOW A BOOM IN DEVICES TO FIGHT POLLUTION

Anonymous

Published in *U.S. News and World Report* v69 n9 p43-4 (31 Aug 1970)

The drive to clean up the environment is spurring development of a host of new products and processes for home, industry, and government. This article describes a number of new products or services for the ecology-conscious,

including a solid waste disposal system; a sewage disposal system; a host of devices for reducing pollution of the air by automobiles; and the use of unleaded gasoline.

Search terms: Air pollution control devices; Air pollution sources; Sewage disposal; Exhaust emission control; Solid waste disposal; Water pollution; Vehicle air pollution; Air pollution emission factors; Lead free gasoline

### HS-009 643 Fld. 5/6

#### IS POLLUTION REDUCTION REALLY NECESSARY?

Anonymous

Published in *Motor* (London) n3559 p30-4 (2 Sep 1970)

3 refs

This paper discusses the problem of the European car manufacturer who must spend money on antipollution devices for his cars so they can meet American standards, when these devices are not needed in Europe. A number of carburetor systems are suggested as means of reducing exhaust emissions. Various modifications in engine design, meant to reduce emissions, are briefly discussed. A summary of Federal, California, European, and world-wide emission control regulations is also provided.

Search terms: Carburetors; Exhaust emissions; Lead free gasoline; California; Engine design; European vehicles; Emission standards; Exhaust emission control devices; Engine modification

### 5/7 Glazing Materials

#### HS-009 644 Fld. 5/7; 5/23

#### THERMOELECTRIC SEALING OF WINDSHIELDS AS PRACTICED IN EUROPE

by D. S. Butler

Bitumen Industries Ltd.

1971 5p

Report no. SAE-710125

Presented at Automotive Engineering Congress, Detroit, 11-15 Jan 1971.

Direct glazing of automobile fixed glass is gaining wider production usage in Europe. Objections on cost grounds are being overcome. New systems and compounds are being developed and employed. The thermoelectric system, with its ease of handling and installation, and lack of associated cleanup problems, seems to be the most popular method in use.

Search terms: Windshields; Windshield mounting; Glazing materials

AVAILABILITY: SAE

### 5/9 Inspection

#### HS-009 645 Fld. 5/9

#### INSPECTION HANDBOOK FOR PASSENGER CARS, TRUCKS AND BUSES, MOTORCYCLES, SCHOOL BUSES, FOREIGN VEHICLES THROUGH 1970 MODELS, WITH MANUFACTURERS' RECOMMENDATIONS

Automobile Manufacturers Assoc., Inc.

Jun 1970 247p

Cover title: *Vehicle Inspection Handbook*.

This handbook is intended as a guide for individual inspectors and for persons responsible for planning and implementing inspection programs based on sound engineering principles. Inspection procedures and causes for rejection are described. The requirements of ANSI Standard D7.1 of 1968 are interpreted. Sections are included on vehicle registration; wheels and tires; steering alignment and suspension; brakes; lighting and electrical system; vehicle glazing; body and sheet metal; exhaust and fuel

systems; vehicle emission control systems; and preventive maintenance.

Search terms: Manuals; Vehicle inspection; Preventive maintenance; Vehicle registration; Wheel inspection; Tire inspection; Steering system inspection; Body inspection; Suspension system inspection; Brake inspection; Electric systems; Foreign vehicles; School buses; Vehicle lighting; Glazing materials; Exhaust system inspection; Fuel system inspection; Lighting inspection; Motorcycle inspection; Bus inspection; Inspection procedures; Glazing materials; Exhaust emission control devices

### 5/10 Lighting Systems

#### HS-009 646 Fld. 5/10

#### THE DIRECTIONAL INTENSITIES FROM HEADLAMP LOWER BEAMS

by A. Fisher

Australian Road Res. Board

Oct 1969 25p 3 refs  
Report no. 9

Directional intensities of light in the lower beam of headlamps were studied to help the Standards Association of Australia draw up a standard for motor vehicle headlamps. Tests were made on American, British, and European units to evaluate glare, illumination, beam spread, and upward stray light. Only one of twelve units completely satisfied the SAE-J579a specification. Several failed only marginally. It was recommended that the specification not be further amended for Australian use, since the best of current units can probably be made to pass the test.

Search terms: Headlamp standards; Headlamp tests; Headlamp glare; Low beamed headlamps; Light transmission; Brightness

## 5/11 Maintenance and Repairs

HS-009 647 Fld. 5/11

### REPAIRABILITY: WHAT ARE ITS PROBLEMS?

by Ben C. Parr

General Motors Corp.

1970 34p

Presented at Pennsylvania Claim Men's Association Annual Convention, Bedford, Pa., 6 Jun 1970.

The interrelationship of the automobile and insurance industries is discussed as it relates to vehicle repairability. A number of vehicle protection features, in particular improved bumper design, are discussed in terms of trade-offs between passenger safety features which may increase vehicle damageability and vehicle protection features which may increase danger to occupants of the vehicle in a collision. It is suggested that the automobile insurance industry has the yardstick, in terms of accident records, to measure the effectiveness of the safety features being designed into cars, and can provide help for the automotive industry to improve both vehicle safety and repairability.

Search terms: Safety device effectiveness; Safety design; Crashworthiness; Automobile safety characteristics; Automobile design; Bumper design; Water bumpers; Energy absorbing bumpers; Barrier collision tests; Insurance industry; Low speed impact tests

HS-009 648 Fld. 5/11

### BASIC FLEET MAINTENANCE

by W. E. Williams

Published in *National Safety News* v102 n3 p56-8 (Sep 1970)

Reprinted from *Traffic Safety*, Mar 1970.

A preventive maintenance program is presented that allows for periodic inspection and scheduling out-of-service periods in advance. Maintenance and inspection records assist in establishing trends and indicate where changes in the program need to be made.

Search terms: Fleet management; Truck maintenance; Inspection records; Maintenance reports; Preventive maintenance

## 5/13 Mirrors and Mountings

HS-009 649 Fld. 5/13; 3/12

### DRIVER EVALUATION STUDY OF REAR VIEW MIRROR REFLECTANCE LEVELS

by T. M. Mansour

Ford Motor Co.

1971 6p 7 refs  
Report no. SAE-710542

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

There has been a lack of information on image brightness in automotive rear vision systems as related to the driver's needs. This paper presents data on driver evaluation of brightness, in the form of visibility and glare ratings of rear view mirror reflectance levels, based upon actual driving experiences. The effects of roadway types and various ambient lighting conditions are discussed, and ranges of acceptable reflectance levels are recommended. The study was a task group effort, performed for the SAE Rear Vision Subcommittee.

Search terms: Rearview mirrors; Brightness; Rear visibility; Glare; Reflectance; Rear windows

AVAILABILITY: SAE

HS-009 650 Fld. 5/13; 3/4

### THE EFFECTS OF CONVEX

## EXTERIOR MIRRORS ON LANE-CHANGING AND PASSING PERFORMANCE OF DRIVERS

by Rudolf G. Mortimer

Michigan Univ. Hwy. Safety Res. Inst.

1971 11p 11 refs  
Report no. SAE-710543

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

Drivers carried out a lane-changing and passing maneuver using convex and plane mirrors alone or in combination with a plane interior mirror. The data showed that the addition of the plane interior mirror compensated for judgmental errors found when convex mirrors were used alone. When the speed difference was 15 mph between the overtaking car and the subject's car, subjects accepted gaps that were too short irrespective of the exterior mirror type. The data suggested that exterior convex mirrors of radii greater than 30 in. may be used reasonably safely by drivers and would have the advantage of providing a considerably increased field-of-view compared to currently used exterior mirrors.

Search terms: Lane changing; Passing; Driver performance; Exterior rearview mirrors; Visibility; Convex mirrors; Decision making; Gap acceptance; Plane mirrors; Field of view; Speed differentials; Headways

AVAILABILITY: SAE

## 5/14 Occupant Protection

HS-009 651 Fld. 5/14; 5/18; 5/20

### ROLL-OVER PROTECTIVE STRUCTURES FOR FARM AND CONSTRUCTION TRACTORS. A 50-YEAR REVIEW

by James F. Arndt

Deere and Co.

1971 9p 25 refs



AUGUST 27, 1971

## VEHICLE SAFETY

Report no. SAE-710508

Presented at Earthmoving Industry Conference, Central Ill. Section, Peoria, 5-7 Apr 1971.

Over the past 50 years, an estimated 30,000 tractor operators have been accidentally crushed under their overturned vehicles. During that time, stability, preventive devices, and education have been tried to reduce the number of such accidents. Within the past 15 years, worldwide activity has been concentrated on developing adequate roll-over protective structures (ROPS) for operator protection. In order to measure the adequacy of the structures, various worldwide performance standards have been created. The latest include those of the SAE, which recognizes the need for a ROPS to absorb energy in order to minimize injury to the operator.

Search terms: Farm tractor design; Construction vehicle design; Antiroll bars; Vehicle stability; Farm tractor accidents; Rollover accidents; Safety design; Design standards; Occupant protection

AVAILABILITY: SAE

HS-009 652 Fld. 5/14; 5/4

### OPERATOR'S ENCLOSURES

by R. N. Sellon

Stolper Industries, Inc.

1971 8p 5 refs

Report no. SAE-710516

Presented at Earthmoving Industry Conference, Central Ill. Section, Peoria, 5-7 Apr 1971.

Design parameters to be considered in developing suitable operator's enclosures, and factors involved in making the enclosure compatible with the particular vehicle are reviewed. Though cab and vehicle designers must cooperate to develop a functional design, they must also take into consideration factors such

as styling, safety, visibility, pressurization, and air conditioning needs. A detailed analysis of sound attenuation in the operator's enclosure is presented. Use of shock mounts, floor mats, fiberglass, perforated hardboard, and spray-on sound deadener are suggested for effective attenuation of sound. Two safety features to take into account are maximum visibility for the operator and roll-over protection in the cab. With proper planning in cab development, the result will be a safe, quiet, pleasant atmosphere in which the operator can work.

Search terms: Sound absorbing materials; Tractor design; Visibility; Air conditioning; Tractor cabs; Noise control; Safety design; Windows

AVAILABILITY: SAE

HS-009 653 Fld. 5/14; 3/1; 2/4

### LET'S STEM AUTO DEATHS WITH A "CAMPAIGN FOR LIFE"

by John A. Volpe

Department of Transp.

Published in *Automotive Engineering* v78 n8 p32-4 (Aug 1970)

Secretary of Transportation John Volpe outlines DOT's attack against death on the highway, with safer automobiles equipped with passive restraint systems such as air bags. A safer car is being designed to protect occupants in high speed crashes, and as an added attraction with a low-pollution engine. The second phase of the program is to get drunk drivers off the road through strict enforcement of tough drunk driving laws. The third part of the program is safer highways.

Search terms: Energy absorbing bumpers; Passive restraint systems; Occupant protection; Drinking drivers; Highway design; Air bag restraint systems; Crashworthiness; Safety cars; Experimental vehicles; Alcohol usage deterrents; Alcohol laws; Highway safety programs

HS-009 654 Fld. 5/14

### "MOMMY, YOU SCARED ME . . ."

Anonymous

Published in *Air Force Driver* v4 n3 p22-7 (Aug 1970)

The problem of protecting small children from injuries in motor vehicles is discussed and some of the requirements of the soon-to-be-released federal motor vehicle safety standard on child seating are summarized. Suggestions for helping youngsters keep occupied during long trips are also provided.

Search terms: Child safety seats; Child injuries; Safety seat design; Safety standards

HS-009 655 Fld. 5/14

### OCCUPANT RESTRAINT PROGRAM

Anonymous

Published in *NBS Technical News Bulletin* v54 n8 p178-81, 184 (Aug 1970)

Testing of seat belt materials, buckles, webbing, and assemblies is conducted by the National Bureau of Standards as part of a vigorous research program on automobile occupant restraint systems. Specifications for webbing include requirements for resistance to abrasion, degradation by light, mildew damage, color change, and color transfer to clothing. Wear of the webbing by an improperly designed buckle is also considered. Tests are conducted under conditions simulating temperature and humidity ranges encountered over the entire North American Continent. Corrosion of metal parts by salt and moisture are examined. Seat belt retractors are tested in dust chambers to study the wear effects and possibility of clogging. Bureau engineers believe the entire restraint system should be tested as a system under dynamic conditions simulating actual crashes. Sled tests with anthropomorphic dummies and human volunteers are also

## 5/14 Occupant Protection (Cont'd.)

### HS-009 655 (Cont'd.)

being conducted. High-speed motion pictures of these tests are being analyzed.

Search terms: Seat belt standards; Webbing; Seat belt buckles; Seat belt reels; Dynamic tests; Anthropomorphic dummies; Seat belt tests; Wear resistance; Materials tests; Wear tests

### HS-009 656 Fld. 5/14; 1/2

#### HAZARDS TO HEALTH. EFFECTIVENESS OF SEAT BELTS IN PREVENTING MOTOR-VEHICLE INJURIES

by Robert G. Frazier

Published in *New England Journal of Medicine* v264 n24 p1254-6 (15 Jun 1961)

8 refs

Several studies on the effectiveness of seat belts in protecting the occupant of a car against serious injury or death are described. The reduction in major or fatal injuries in the various studies ranges considerably, one study suggesting 35% while another suggested 60 to 80%. The role of seat belts in preventing ejection is discussed. Percentages of actual seat belt use are also discussed.

Search terms: Seat belt effectiveness; Ejection caused injuries; Injuries by seat occupation; Fatalities by seat occupation; Seat belt usage; Injury prevention; Injury severity; Fatality prevention

### HS-009 657 Fld. 5/14

#### AIR BAGS BY '73?

Anonymous

Published in *Fleet Owner* v65 n9 p60-2 (Sep 1970)

A number of passive restraints are being considered by the automotive industry to meet the federal government deadline of January 1, 1973 for mandatory installation in automobiles. Air bags are the most often discussed system, but others being considered include deployable nets and crash blankets. The standard requires effective protection in head-on collisions at 30 mph, lateral collisions at 15 mph, and rollovers at speeds up to 60 mph. Despite significant research advances, the industry maintains it cannot meet the imposed deadline.

Search terms: Air bag restraint systems; Net restraint systems; Safety standards; Safety standards compliance; Passive restraint systems; Blanket restraint systems; Lead time

## 5/15 Propulsion Systems

### HS-009 658 Fld. 5/15

#### CONTROL SYSTEMS FOR MEDIUM SIZE GAS TURBINES

by Jan Ederveen

Woodward Governor Co.

1971 12p

Report no. SAE-710549

Presented at Society of Automotive Engineers mid-year meeting, Montreal, 7-11 Jun 1971.

This paper describes a modular concept for fuel controls used with medium-size, split-shaft gas turbines in the 8,000-25,000 hp range. Modifications allow the use of the same components for virtually any gas turbine application. The modular system combines a number of standard components such as fuel valves, limiters, electronic circuits, and station controls together with commercially available items, such as shutoff valves, pressure regulators, etc. Special items to suit a particular specification can easily be added. The demand for larger blocks of power caused an increase in the application of electric generators

driven by two or more aircraft-type gas generators. These installations introduce some unique control problems with respect to load division between gas generators. For such installations using combined cycles (by adding independent head recovery units) the load division between gas generators might have to be unbalanced to suit the demand on the heat recovery units.

Search terms: Gas turbine engines; Electric governors; Speed control; Control equipment; Fuel flow; Gas generators

AVAILABILITY: SAE

### HS-009 659 Fld. 5/15; 4/7

#### DIGITAL COMPUTER METHODS FOR PREDICTION OF GAS TURBINE DYNAMIC RESPONSE

by A. J. Fawke; H. I. H. Saravanamuttoo

Gas Council Engineering Res. Station (England); Carleton Univ. (Canada)

1971 10p 22 refs

Report no. SAE-710550

Methods of simulating gas turbine transient behavior are reviewed. Two digital computer methods are described, one assuming instantaneous flow match and the other making use of intercomponent volumes to compute the rate of change of pressure at different locations. Results are shown for a variety of engines, good agreement between engine test and simulation being achieved in each case.

Search terms: Gas turbine engines; Mathematical models; Computerized simulation

AVAILABILITY: SAE

### HS-009 660 Fld. 5/15

#### CONTROLS FOR SINGLE SHAFT GAS TURBINE VEHICLES

by Bernard B. Poore

Deere (John) Technical Center

1971 8p 1 ref  
Report no. SAE-710551

Presented at SAE mid-year meeting,  
Montreal, 7-11 Jun 1971.

The single-shaft gas turbine is a satisfactory vehicular power plant when an infinitely variable transmission is available and a suitable control system is provided. Vehicle operating requirements and single-shaft turbine characteristics must be considered to develop the control concept. An integrated electronic turbine-transmission control system provides the needed flexibility for varying application of this power system. Satisfactory operation of such a system in two modes is demonstrated by results of field evaluation of a test vehicle.

Search terms: Turbine shafts; Torque; Transmissions; Gas turbine engines; Vehicle control; Speed control; Engine speeds

AVAILABILITY: SAE

HS-009 661 Fld. 5/15

# PROSPECTS FOR ELECTRIC VEHICLES. A STUDY OF LOW-POLLUTION-POTENTIAL VEHICLES-ELECTRIC

Little (Arthur D.), Inc.

Oct 1969 106p  
Contract PH-86-67-108  
Report no. PB-194 814; APTD-69-52

Earlier version of this report appeared as HS-008 751.

A state of the art study has been conducted on the technology on which the future development of electric highway vehicles depends. The assessment is made on the basis that there will be no major change in the patterns of urban transportation and focuses upon the

technical requirements of the vehicle. Technical and cost criteria were established for six classes of electric vehicles, most of which correspond closely in performance to existing conventionally powered types. On the basis of these criteria the prospects for vehicle application of various electric motor and control systems and a wide range of electrical power sources including batteries, fuel cells, and engine-generator-battery hybrids are compared. The most promising systems for further development are identified and recommendations made for the expansion of effort in these areas.

Search terms: Electric automobiles; Electric motors; Batteries; Fuel cells; Hybrid batteries; State of the art studies; Hybrid vehicles; Urban transportation; Electrochemical cells

AVAILABILITY: NTIS

HS-009 662 Fld. 5/15

# THE SEARCH FOR A LOW-EMISSION VEHICLE. STAFF REPORT

Congress. Senate Commerce Com.

1969 153p refs  
Report no. 26-248

91st Congress, 1st Sess.

This report reviews the air pollution problem in the United States, and cites the automobile as the primary villain. Effective means of truly controlling or reducing the pollution from the internal combustion engine do not appear likely in the foreseeable future. The approach suggested here is the substitution of a new system which produces few pollutants and performs as well or better than the present power plant, specifically the Rankine cycle or vapor cycle system. Steam automobiles are also discussed. Recommendations for curbing air pollution are listed, including purchase of low emission cars for Federal, state, and local government use and tax incentive for owners of low emission vehicles. The

report urges DOT and HEW to encourage development of alternate propulsion systems. The appendices contain correspondence with automotive industry representatives concerning research in the low emission vehicle field and selected journal articles on the same subject.

Search terms: Vehicle air pollution; Emission standards; Rankine cycle engines; Internal combustion engines; Vapor engines; Automobile design; Automotive industry; Hydrocarbons; Nitrogen oxides; Carbon monoxide; Air pollution emission factors; Leaded gasoline; Steam automobiles; Government vehicles

AVAILABILITY: GPO

HS-009 663 Fld. 5/15

# THE DESIGN AND DEVELOPMENT OF A TURBINE-GEAR-BOX FOR USE IN AN AUTOMOTIVE ORGANIC RANKINE CYCLE SYSTEM

by Robert E. Barber; John C. Bond; Everett H. Alford

Barber-Nichols Engineering Co.; Lear Motors Corp.

1971 10p  
Report no. SAE-710564

Presented at Society of Automotive Engineers mid-year meeting, Montreal, 7-11 Jun 1971.

This paper summarizes the design and development of a small, lightweight, efficient, high-speed, turbine prime mover and a speed reducing gearbox. The turbine aerodynamic design and mechanical design are shown. The gearbox reduced the turbine's high (45,000 rpm) speed to the low (3,800 rpm) output speed necessary for use in a conventional, three-speed automobile transmission. Complete fabrication of the turbine-gearbox was accomplished in approximately five weeks, and the problems and procedures used are described. The initial development tests are also summarized.

**5/15 Propulsion Systems (Cont'd) HS-009 665 Fld. 5/18**

**HS-009 663 (Cont'd.)**

Search terms: Rankine cycle engines; Gear boxes; Engine design; Engine performance; Engine tests; Turbine engines

AVAILABILITY: SAE

**5/18 Steering Control System**

**HS-009 664 Fld. 5/18; 4/7**

**SIMULATING TRACTIVE PERFORMANCE**

by R. L. Pershing

Deere and Co.

1971 10p 5 refs  
Report no. SAE-710525

Presented at Earthmoving Industry Conference, Central Ill. Section, Peoria, 5-7 Apr 1971.

A new simulation technique has been developed which shows considerable utility in predicting the tractive performance of four-wheel-drive vehicles. This technique overcomes the usual difficulty encountered in solving a set of nonlinear equations to determine vehicle forces. A unique feature of the model is the prediction of individual wheel forces and slips, thus aiding design of the distribution of tractive power. The simulated results are compared with tractive forces measured on a JD540 Skidder Tractor having four-wheel drive and frame steer. The purpose is to illustrate the general technique of solving the mathematical force model to determine the soil-wheel forces and other vehicle forces and moments for a four wheel drive vehicle having frame steer.

Search terms: Equations of equilibrium; Four wheel drive vehicles; Mathematical models; Traction; Slip; Vehicle stability; Vehicle soil interface; Slip sinkage; Loss of control; Steering force; Tire forces

AVAILABILITY: SAE

**DETERMINATION OF WHEEL LOADER STATIC AND DYNAMIC STABILITY**

by Dale H. Unruh

Caterpillar Tractor Co.

1971 8p 6 refs  
Report no. SAE-710526

Presented at Earthmoving Industry Conference, Central Ill. Section, Peoria, 5-7 Apr 1971.

The development and verification of a mathematical model and analytical techniques for the analysis of wheel loader static and dynamic stability are described. Resulting computer programs allow designers to predict stability in the concept stage of design. An example is presented to illustrate the usefulness of this technique in regard to an earth-moving vehicle.

Search terms: Vehicle dynamics; Mathematical models; Vibration; Construction vehicles; Vehicle stability; Dynamic loads; Static loads; Wheel performance; Equations of motion

AVAILABILITY: SAE

**HS-009 666 Fld. 5/18**

**STABILITY ANALYSIS OF AN ARTICULATED VEHICLE STEERING SYSTEM**

by Rolland D. Scholl; Richard E. Klein

Caterpillar Tractor Co.; Illinois Univ.

1971 6p 6 refs  
Report no. SAE-710527

Presented at Earthmoving Industry Conference, Central Ill. Section, Peoria, 5-7 Apr 1971.

A steering system for an articulated vehicle was analyzed to gain an improved understanding of the closed loop

stability characteristics. The analysis was applied to an electrohydraulic system and is applicable to more general types of systems. Since the parameters of electrohydraulic valves are well known, a simulation model including the hydraulic system and the vehicle dynamics was easily derived. Using the simulation, the oil mass resonance was determined to be the most critical parameter and was controlled by adding compensation in the steering system closed loop. The paper describes the steering system, simulation model, and stability criteria.

Search terms: Articulated vehicle performance; Hydraulic steering systems; Simulation models; Vehicle stability; Computerized simulation; Resonance

AVAILABILITY: SAE

**HS-009 667 Fld. 5/18**

**IMPROVEMENT OF SAFETY OF AUTOMOBILE AS MAN-MACHINE SYSTEM AT HIGH-SPEED RUNNING**

by Oamu Hirao; Yoshihiro Matsuura; Michio Miyabe

Tokyo Univ. (Japan); Mitsubishi Heavy Industries Ltd. (Japan)

May 1968 25p 3 refs

Summary in German and French. Presented at 12th Congress International des Techniques de l'Automobile, Barcelona, 19-25 May 1968.

The most fundamental problem for automobile safety at high speed is to improve the course-tracking performance of the man-automobile system. The stability of the system at high speed must be considered as a closed loop control system. The driver detects the deviation from the course and operates the steering wheel of his automobile. According to his operation, the automobile should respond and feed back the necessary information for his next operation. Two factors control the stability of such a system when it receives some lateral disturbance: (1) the

phase lag between the detection and the output of the response, and (2) the amount of the feedback gain. Thus, it should be possible to improve the stability of the system at high speed by adding some derivative items having phase-advancing functions to the steering system, according to the speed. This has been proven with experiments conducted on an automobile test stand. A prototype having a hydraulic phase-advancing device for a normal power steering system has been manufactured and tested.

Search terms: Steering system design; Driver reaction time; Man machine systems; High speed; Vehicle dynamics; Tracking Automobile tests; Gain; Mathematical analysis; Vehicle stability; Vehicle control; Hydraulic equipment; Power steering systems; Automobile safety characteristics

**HS-009 668 Fld. 5/18; 5/1**

### STEERING AND BRAKING SYSTEMS ON THE ARTICULATED MOTOR GRADER

by Lon B. Eberhart

Deere (John) Dubuque Tractor Works

1971 10p

Report no. SAE-710530

Presented at Earthmoving Industry Conference, Central Ill. Section, Peoria, 5-7 Apr 1971.

The steering and braking systems used on the all-hydraulic JD-570 articulating grader were designed with the safety of the operator in mind. These systems are given priority over the other related hydraulic systems on the grader through the use of a priority valve. An accumulator is provided to store hydraulic energy for the steering and braking systems in the event of a power failure. In addition, the brake valve is capable of acting as a pump to supply pressure oil to the service brakes, if required. A mechanically actuated secondary brake effective on all four tandem wheels is also provided.

Search terms: Articulated vehicles; Hydraulic brakes; Hydraulic steering systems; Brake systems; Construction vehicles; Safety design; Hydraulic design factors

AVAILABILITY: SAE

### 5/20 Trucks and Trailers

**HS-009 669 Fld. 5/20; 2/7**

### TRUCK SPRAY ON WET ROADS REDUCED BY NEW FENDER DESIGNS

by Irmin O. Kamm; Gilbert A. Wray; Richard G. Kolb

Published in *Automotive Engineering* v78 n9 p28-31 (Sep 1970)

Guidelines for the design of fenders that reduce the spray and mist thrown up by trucks operating on wet pavements have been developed as a result of laboratory tests performed in the Davidson Laboratory of Stevens Institute of Technology and verified by field tests. Laboratory and field tests are described.

Search terms: Fender design; Splash control; Tractor trailers; Wet road conditions; Laboratory tests; Field tests

**HS-009 670 Fld. 5/20; 5/18**

### PICKUP TRUCKS FOR USE WITH CAMPER BOXES

Anonymous

Published in *Consumer Reports* v35 n8 p490-7 (Aug 1970)

Consumers Union tested four three-quarter ton pickup trucks with standard eight-foot pickup beds. Ride and comfort, handling and steering, brakes, engines, and performance were evaluated with and without a heavy and a light camper box. All four vehicles exhibited serious shortcomings with the heavy

camper. They showed a decided tendency to go out of control in an emergency stop, and serious body lean on entering a turn. As a result, only one model was rated acceptable with a camper box and then only if the total weight of passengers, box, and gear did not exceed 2,000 pounds. Even with this model, there was marginal resistance to brake fade, and use of the gears to slow the truck down on long grades was recommended.

Search terms: Campers (truck mounted); Pickup trucks; Truck brakes; Truck handling; Brake tests; Truck performance; Truck stability; Cornering; Steering; Vehicle weight; Brake performance; Vehicle riding qualities; Road tests; Truck tests

**HS-009 671 Fld. 5/20**

### THE HISTORY OF THE MOTOR HOME AS A RECREATIONAL VEHICLE

by Kenneth T. Scott

Family Motor Coach Assoc., Inc.

1971 6p

Report no. SAE-710118

Presented at Automotive Engineering Congress, Detroit, 11-15 Jan 1971.

Through the years, the motor coach is fast becoming a new way of life. Today, the motor coach is a self-contained, motor driven home, complete with all the necessary conveniences, and in some cases, even the luxuries. It is finding a way in our everyday living as people seek more leisure time and as families anticipate traveling together.

Search terms: Recreational vehicles; Mobile homes

AVAILABILITY: SAE

## NHTSA DOCUMENTS

HSL No. 71-23

### 5/22 Wheel Systems

HS-009 672 Fld. 5/22

#### AUTOMOBILE TIRES

Anonymous

Published in *Consumer Bulletin* v53 n8 p24-8 (Aug 1970)

The various types of tires available for passenger cars are described, and their advantages and disadvantages are listed. These include bias tires, bias-ply belted tires, and radial belted tires. Other tire terms such as wide-tread, radial-ply and two-ply are explained. Special usage tires are also described: nylon tires, retreads, whitewalls, snow tires, and studded tires. Proper care of tires includes checking regularly to see proper inflation pressures are maintained to avoid excessive wear.

Search terms: Wide oval tires; Bias belted tires; Nylon tires; Radial tires; Retreaded tires; Rear tires; Snow tires; Studded tires; Tire inflation pressure; Tire performance; Tire temperature; Tire wear; Tire characteristics

HS-009 673 Fld. 5/22

#### UPGRADE YOUR TIRES AND WHEELS

by Mark S. Kohler

Published in *Woodall's Trailer Travel* v36 n9 p61-4, 66, 96, 98, 100-3 (Sep 1970)

The results of a survey of tires and wheels in use on travel trailers is reported. In general, most readers upgraded their tires and wheels to handle additional weight, either because stated weight of the trailer was not accurate, or to allow for extra weight to be added. Others wanted to improve handling and stability characteristics. In upgrading tires and wheels, one must consider also inflation pressures and operating speed. Size designations, tire materials, and other tire characteristics are discussed.

Search terms: Tire characteristics; Tire quality; Tire selection; Tire per-

formance; Tire inflation pressure; Tire materials; Travel trailers; Tire sizes; Vehicle weight; Vehicle handling; Vehicle stability; Wheels

HS-009 674 Fld. 5/22

#### WHAT'S IN A TIRE?

by Mark S. Kohler

Published in *Woodall's Travel Trailer* v36 n9 p61-4, 103-5 (Sep 1970)

Selection of materials and method of fabrication of the pneumatic tire are explained. Factors considered in making the selection are listed.

Search terms: Tire characteristics; Tire materials; Tire cords; Pneumatic tires; Tire treads; Tire design

HS-009 675 Fld. 5/22

#### THE COMPROMISE IN TYRE DESIGN

by Geoffrey Howard

Published in *Autocar* v133 n3889 p2-4 (17 Sep 1970)

Problems are being encountered when automobile tires designed for the road conditions in one country are used in another where conditions may be considerably different. An open-air laboratory for road testing and evaluating tires has been built by Pirelli S.p.A., at Vizzola near Milan, Italy. The facility is described and some of the initial test results are reported. The emphasis is on study of tire-to-road contact.

Search terms: Test tracks; Tire design; Tire tests; Tire road contact forces; Tire pavement interface

HS-009 676 Fld. 5/22

#### NATURAL RUBBER IN WINTER TYRES AND INDUSTRIAL TYRES

by K. A. Grosch; E. Southern; A. Schallamach; P. McL. Swift

Published in *Rubber Developments. NR Technology* n9 p1-12 (1970)

4 refs

Presented at the International Rubber Conference, Moscow, Nov 1969.

The skid resistance and wear characteristics of natural rubber and synthetic rubber are compared in winter tires and industrial tires, where low tire surface temperatures are experienced. Oil extended formulations of both the natural and synthetic rubbers are also tested. For winter tires, the best skid resistance at continually sub-zero temperatures is obtained with natural rubber treads. If the tires will also be driven on wet roads, oil-extended natural rubber with polybutadiene added provides the best balance of properties. Studs increase skid-resistance in snow, but have low skid resistance on wet roads, and may lead to excessive road wear. For industrial tires, natural rubber also offers the best combination of wear resistance, as well as low rolling resistance. In general, the rougher the conditions, the greater the relative superiority of natural rubber.

Search terms: Rubber; Synthetic rubber; Rubber compounds; Tire skid resistance; Wet skidding; Tire materials; Tire wear resistance; Snow tires

## NHTSA DOCUMENTS

HS-810 174 Fld. 5/0

#### PEOPLE IN THE NEWS

by Douglas Toms

National Hwy. Safety Bureau

Published in *Automotive Engineering* v78 n8 p52-4, 83-4 (Aug 1970)

AUGUST 27, 1971

NHTSA DOCUMENTS

Douglas Toms outlines highway safety priorities. He lists the top priority program as crash survivability, with alcohol countermeasures coming second. Third is the long range development of an experimental safety vehicle which would avoid crashes through improved handling, braking, visibility, and lighting. Passive restraints are being developed because

people won't use safety belts. Physiological test devices may be installed on the cars of problem drinkers, but probably not on all cars. Mr. Toms also discusses the role engineering societies can play in reducing highway accidents and the relationship between government and the automotive industry.

Search terms: Highway safety programs; Passive restraint systems; Vehicle safety; Drinking drivers; Alcohol usage deterrents; Driver physiological test devices; Experimental vehicles; Safety cars; Automotive industry; Government industry cooperation; Air bag restraint systems; Priorities; Crashworthiness; Accident survivability





# executive summary

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## A SYNOPSIS OF A RECENTLY RELEASED NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION RESEARCH REPORT

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### MULTIDISCIPLINARY CRASH STUDY TEAM SUMMARY REPORT (FINAL REPORT)

The purpose for which Contract FH-11-7224 was awarded was to organize and train professional, university based, personnel into a multidisciplinary research team and to establish a continuing program for the investigation of motor vehicle accidents in an assigned area to determine accident and injury causation. From these investigations the research team is required to provide complete information collected from selected damaged automobiles, produce appropriate data feedback to assess current safety design, formulate scientifically-based proposals for vehicle safety improvement, and provide suggestions to federal and local governments so that improved legislative programs can be initiated.

Contract No. FH-11-7224  
The University of Miami  
5225 Ponce De Leon Blvd.  
Coral Gables, Florida 33146  
DOT/HS-800 371 PB-196 305

Award Amount: \$171,387.00  
First Report Due: 1-31-71  
Report Received: 12-14-70

#### General Comments

The study team consists of professionals from the fields of engineering, law, medicine, safety, sociology and vehicle maintenance. There were twelve such professionals and eight support technicians and personnel who participated in this study.

For purposes of clarification, an accident is defined as "an event which takes place without one's foresight or expectation, by chance, or by contingency." Based on the strict definition of the word there are few automobile accidents. Based on a standard misuse of the word all automobile incidents are called "accidents."

The Crash Study Team at the University of Miami completed its first year of study of thirty crash incidents. The scope of the study encompassed crash incidents in which there was property damage, personal injury, fatality or any combination thereof. The cases were selected primarily on the basis that an involved vehicle be of the model year 1968 or later. Certain cases which did not meet the criteria of vehicle year were selected based on their individual merit and

particular relationship to a characteristic not related to model year of vehicle (e.g., traffic engineering hazards, human factors involvement or assignment by the Department of Transportation).

#### CONTRACTOR'S PRESENTATION OF MAJOR FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

##### 1. *Present drivers licensing programs are inadequate.*

Our Team findings lead us to endorse the National Highway Program Standard 4.4.5; recommending special priority for physical, written and behind-the-wheel driver license examinations capable of measuring a candidate's condition, knowledge and skill. We further suggest a special test segment covering defensive driving tactics which enable responsible drivers to prevent most "non-chargeable" crashes.

Often, safety "experts" identify driver attitude as the most important aspect of safe driving, then bemoan the "fact" that it is difficult or impossible to measure. We believe attitude testing is possible, reasonable, and economically feasible by specifying that each driver's

official record be included as a part of periodic re-examination; moreover, our Team proposes that this segment of re-examination should include the driver's total "legal reputation" since available evidence suggests a strong correlation between other criminal misconduct and the probability of traffic crash experience.

Present programs relating to the revocation or suspension of driving privileges seem to occur at the documentary level only. To provide meaning for this important sanction, a program of effective surveillance is required. Driver improvement, a noble aim, is possible when the needs of an errant driver are understood. A diagnostic procedure revealing specific problems of attitude, skill, knowledge, or physical ability seems a prerequisite to tailoring effective remedial action.

#### RECOMMENDATIONS

- Research to identify minimum physical, knowledge, and skill requirements for safe operation of motor vehicles.
  - More comprehensive physical, written and behind-the-wheel drivers license examinations for each class of vehicle to insure that applicants meet requirements.
  - A Defensive Driving Tactics segments of the written examination.
  - Periodic re-examination should include a review of the driver's traffic and criminal record, with minimum performance specifications.
  - Effective surveillance to insure compliance of revocation or suspension orders.
  - Diagnostic programs to identify specific weaknesses of problem drivers.
  - Tailored driver improvement programs to remedy identified problems.
2. *The apparent leading cause of fatal vehicular crashes is the influence of alcohol on the driver.*

Previous studies (1968 Alcohol and Highway Safety Report, U. S. Government Printing Office, 1968) as well as local (Dade County) experience proves that alcohol abuse plays a most significant role in driver impairment leading to fatal crashes. Despite this prior

knowledge, there seems to have been little change for the better.

A number of the cases in this study have demonstrated some of the factors leading to lack of control over the alcohol problem. In addition, our experience with non-crash study cases is similar. The plain fact is that governmental agencies charged with the responsibility for public safety have chosen not to exercise their capabilities and authority to the extent they should.

The passage of a law authorizing the obtaining of blood or breath, from a driver suspected of being intoxicated, for the purpose of obtaining a blood alcohol level does not insure that this information will be available for police or crash investigators. If the person is arrested for driving while intoxicated and brought into jail, a breathalyzer test can be performed. If, however, he is not arrested, or if he has injuries and is treated at a hospital, great difficulty has been experienced in obtaining a blood sample for test. When a sample is finally obtained, often several hours have elapsed and the alcohol level is lower than it was at the time of the incident. Doctors, nurses and laboratory technicians sometimes refuse to draw blood when requested by the police for fear of legal implications and time lost being subpoenaed to testify in court.

Repeatedly, we have noticed that investigators choose not to request an alcohol test when such a request would be of aid. The reason given is that they could not successfully prosecute so why bother.

Investigating officers should not bear full responsibility for this attitude. In actual fact it represents, at the field level, the attitude throughout the full level of government. Unless the chief executive of any governmental unit addresses himself to this problem in a forceful and consistent manner, the forces of control become vitiated. The public assumes that government is doing the job; and the government does not respond, allegedly due to public apathy. In actual fact, neither the governmental agencies nor the public are fully informed.

The remedy is both legislative and educational. Legislative recourse must be sought in nationwide uniform liquor control laws including mandatory roadside screening tests for intoxication in severe crashes, uniform implied consent and chemical test laws, and effective remedial programs for alcoholics. Even though properly administered implied consent and chemical test legislation can identify drivers with an alcohol-related problem, there is presently no real

program to correct this problem. Present legal remedies are limited to incarceration, fine and revocations or suspension of the driving privilege. But alcoholism is the problem, and none of these is designed to cure or control alcoholism. An educational effort must be directed toward selected echelons of government in the executive, legislative and judicial branches. Such a program must be forceful, repetitive and designed to bring disrepute upon those in responsible positions in government who fail in their responsibility toward furtherance of public safety.

#### RECOMMENDATIONS

- A model procedure should be developed whereby hospital personnel may draw blood at the request of the police but not be involved in the chain of evidence, and thus be assured that they will not be subpoenaed to court.
  - Law enforcement agencies and/or personnel having jurisdiction over traffic cases should be authorized and required to command a blood alcohol test for all operators of vehicles involved in a crash with resultant injuries being coded either A or K.
  - Pilot projects for developing remedial/treatment programs for alcoholic drivers should be undertaken as a joint venture involving courts, health agencies, and other community organizations to develop an effective alternative to jails, fines, or license revocations.
3. *Unnecessarily severe injuries are being sustained by vehicle occupants in crash incidents and would be substantially reduced by utilization of available restraint systems.*

There is no question at all, in the opinion of the members of the Univ. of Miami Team, regarding the value of restraint systems provided that they are used. Two avenues of attack are open, which will yield fruitful returns and regarding the problem of non-restrained crash vehicle occupants. One lies with the insurance industry, the other in the hands of the judiciary.

#### RECOMMENDATIONS

Research based on correlation of vehicle damage and occupant injury define the feasibility of offering "restraint system" insurance, valid only for occupants wearing restraints, at reduced rates.

- Legislation requiring all occupants of motor vehicles to wear restraint systems (similar to helmet law for motorcyclists with the same rationale).
  - An educational program to encourage judicial notice of the lack of use of restraints (in automobile crash liability cases).
4. *The integrity of presently designed passenger compartments must be improved significantly.*

The manufacturers of automobiles should consider occupant protection as their prime constraint in the design of passenger compartments. It is probable that style and initial production costs are the overriding factors influencing vehicle design. While such an attitude may be based on competitive requirements for producing a sufficiently low-priced vehicle which the public will accept, it nevertheless results in a greater cost to the public when actual dollar losses due to crash incidents are considered.

The lack of adequately designed passenger compartments is a basic cause of occupant trauma during the crash phase, especially in so-called "compact" cars.

Attention is directed to the special vulnerability of automobiles to intrusion from side impacts by striking vehicles or fixed objects struck "broadside" in one-car crashes.

#### RECOMMENDATIONS

- Research to design an optimum cage consisting of continuous structural rib frame members located at the A, B and C pillars (d, if applicable) with other connecting continuous structural frame members. (A conceptualized drawing is presented in the report.)
  - A lateral spar through the front seat (or back rest) in the center of passenger vehicles at standard bumper height to reinforce B pillars.
  - Establish minimum standards for allowable passenger car deformation under certain types of impacting.
5. *All non-transparent interior passenger compartment surface must be protected with non-flammable energy absorbing padding to significantly reduce injury experience.*

There is significant variability of interior padding in vehicle passenger compartments. The amount of

padding appears to be related to the "quality" (viz: model, etc., cost, etc.) of vehicles, thus the comments previously made in the discussion of Conclusion No. 4 also apply here.

#### RECOMMENDATIONS

- Better non-flammable energy absorbing padding materials should be developed.
- Standards should be set to insure the use of acceptable materials for padding all non-transparent passenger compartment interior surfaces.
- All upholstering materials used in automobiles should be non-flammable, or reduced flammability.
- Special attention should be given to improving the energy absorbing qualities of dash "C" panels due to the high frequency of impacts by lower extremities of front seat occupants.

#### 6. Future design must include standardization of exterior contact components.

The majority of crash incidents resulting in fatalities, serious injury and property damage involve two or more vehicles, with contacts between such vehicles occurring in combinations of front, side and/or rear impacts. The primary constraints of "bumper" design is apparently that of style, or at least, protection of the vehicle being designed. Little or no consideration is given to protection of other vehicles being struck, thus there is no true standardization of exterior contact component system of vehicles.

In addition to other vehicle safety design improvements, the standardization of bumper heights on all vehicles is an absolute necessity. There is a need for "bumpers" (energy absorption type) around the passenger compartment, not just on the two ends. Such a bumper could be integral part of a passenger cage.

While such a passenger compartment protection system should protect the occupants during a crash phase, it must also resist unreasonable deformation during low-speed impacts to preclude unnecessary property damage.

#### RECOMMENDATIONS

- Research leading to the development of an integrated energy absorbing bumper system. (A

passenger "cage" would provide for a solution of two major problems in current design.)

- Standards should be set which rigidly define the location, energy absorption and strengths of bumper systems.

#### 7. Minimum safety standards for transportation system design, construction and maintenance are required.

Many years of experience in design, construction, and maintenance of our interstate systems have revealed design inadequacies which can be eliminated in future highway construction, provided that the lessons learned are considered in new design projects.

There is a definite need to immediately begin the development of a manual of minimum safety engineering standards on the federal level. There are few safety engineering standards currently established and those few are thinly spread among other standards, and the reason is usually associated with other phenomena. Of many applicable examples some few are given as follows:

<i>Design Standards</i>	<i>Criteria</i>
Max. vertical grade	Vehicle performance in negotiation
Max. degree of curvature	Passenger comfort
Compound curvature on exit ramp	"Economy" in right of way purchase
Rigid** sign supports	Structural stability in wind storms

#### RECOMMENDATIONS

- The federal government should enact certain federal minimum safety engineering standards so as to provide uniformity throughout the country and eliminate inefficient hazardous and varying designs.
- The federal government should then require that all states which choose to participate in federal highway funding adopt their own conforming or stricter standards.

\*\*One inch support in current use in an 8" wide flange I-beam connected to 3" diameter concrete "deadmen" with 1.125 diameter case hardened steel bolts.

## OTHER RECOMMENDATIONS

### • Legal Reputation:

It is recommended that a "search-procedure" be established to check all licensed vehicle driver's records periodically to attempt to recognize habitual offenders so that appropriate remedial programs can be initiated.

### • Drivers Licence Check:

It is recommended that each state develop a drivers licence check procedure permitting authorized agencies to quickly check the status (suspended, revoked) of individual licenses. The system should be set up so that inquiries from anywhere within the state to a terminal (from an authorized agency) would activate a rapid computer search for the status of a specific license.

### • Motor Vehicle Purchasing/Renting:

It is recommended that prior to the purchase or rental of a motor vehicle, the dealer be required to check with the appropriate state agency to ascertain if the license of the purchaser/renter is suspended or revoked; and if such purchaser/renter has a suspended or revoked license the dealer should be required by law to refuse to sell or rent a vehicle to that individual.

### • Motorcyclists:

It is recommended that all motorcyclists be required to wear certain types of safety attire and equipment (boots, jackets, etc.) in addition to helmets to reduce crash injuries.

### • Re-examination of Licensed Drivers:

It is recommended that re-examination be required of all surviving drivers of fatal or serious injury motor vehicle crashes to determine their driving capability. Such re-examination should include a physical examination with an eye test (including peripheral vision); a written examination covering rules of the road and defensive driving tactics; and a behind-the-wheel test in the same type vehicle.

### • Vehicle Lighting Systems:

It is recommended that all vehicle lighting systems be standardized regarding heights from the road-

way and distance between lights (to help in nighttime depth perception interpretation of distance and closure rate between vehicles). It is further recommended that all vehicles be required to maintain "running-lights" on their sides.

It is further recommended that a redesign of brake lights be considered wherein, upon a driver reducing pressure on the gas pedal, an amber rear light becomes visible until the brake light is actuated so as to warn following drivers of the activities regarding vehicle speed. Such a device will provide "early warning" to drivers of closing vehicles.

### • "Muscle" Cars:

It is recommended that the federal government establish standards to prescribe with minimum and maximum allowable HP: weight ratios for street vehicles. Unreasonably high ratios preclude discretionary acceleration required for merging and passing maneuvers.

### • G.M. Automobiles:

The current location of the rear view mirror system in certain G.M. vehicles is such that the driver's view to his right front is blocked. A vehicle approaching from the right (at a velocity matching that of the G.M. vehicle) will be blocked from the driver's view by the rear view mirror. It is recommended that the rear view mirror location be redesigned.

### • "Volkswagen Syndrome"

It is recommended that immediate research be undertaken to ascertain if certain characteristics of small compact vehicles are responsible for vehicular crash incidents and/or severe occupant injury (viz: high center of gravity causing roll-overs, lack of front mass to transmit and absorb crash energy - rear motor syndrome - aerodynamic scoop design on front of vehicle causing "submarining" under striking objects, proximity in crash phase, etc.)

### • Tubeless Tires:

It is recommended that consideration be given to redesigning rims to prevent air spilling from tubeless tires during side skid maneuvers. The most immediate solution is to require tubes in all tires.

- **Public Transportation Systems:**

It is recommended that all public transportation systems be required to install adequate padding and restraint systems for their passengers so as to provide a safer environment.

- **Pop-Out Windshields:**

Some vehicles still include "pop-out" windshields in their design, viz: Volkswagen and Toyota. It is recommended that such windshields be outlawed since their ejection during collision allows vehicle occupants to be ejected, thereby increasing the probability of severe injury.

- **Fuel Tank Penetration:**

It is recommended that a study be instituted regarding the problem of structural frame members which protrude during front to rear crash impacts, and the concurrent vulnerability of present fuel tank location in typical passenger vehicles.

- **Magnesium Rims:**

It is recommended that strength standards for wheel rims be established and enforced.

- **Head Restraints:**

It is recommended that solid bar-type head restraint supports be required as a standard to preclude failures noted in tube type head restraint supports, especially at adjustment notches.

## ENVIRONMENTAL FACTORS

- **Construction Under Traffic:**

For roadway construction which is being effected "under traffic" it is recommended that all open ditches be covered at the end of each work day, that patrol watchmen be on duty and that flagmen be placed at and along the construction length to signal motorists of construction activities.

- **Construction Barriers:**

It is recommended that barrier standards be set as related to required number, type and location on construction jobs and further, that the contractor be required to place a cash "barrier-bond" for

each job. Any officer of an official agency inspecting the construction area (at any time) who deemed that the barrier standards are not being met should have authority to call an appointed barrier rental agency. Such an agency would then place barriers as required and place a billing against the "barrier-bond" for payment.

- **Expressway Sign:**

It is recommended that standards be established regarding the number of signs allowed within certain distances of decision-making areas on expressways and that directional signs be standardized with respect to location (both distance from area defined; or sign and location with respect to pavement edge).

- **Stop Signs:**

It is recommended that the feasibility of placing two "STOP" signs back to back, on every applicable sign post be determined. At intersections where two posts are placed (one for a "STOP" sign in each direction) there would then be four signs showing (two in each direction).

- **Rural Areas:**

In rural areas where vandalism and theft of traffic control signs is evident, it is recommended that effective "stop bars" and the letters "STOP" be painted on appropriate road surfaces with warning symbols painted on the road surface in advance of the stop intersection.

- **Curb Faces:**

It is recommended that a redesign of curb faces be accomplished to reduce the probability of a striking wheel "climbing" the face of the curb and invading roadside areas.

- **Railroad Crossing:**

It is recommended that at *all* railroad grade crossings illuminated, audible, and animated signals be required.

- **Median Separation:**

It is recommended that all expressways and high-speed road-ways should have adequate median separation structures (walls, railing or distance). In other areas, at overpasses and under-

passes, median protection should be provided where center bridge supports are unguarded.

- Roadside Hardware:

It is recommended that all roadside hardware be of the breakaway variety, or be guarded by energy absorbing devices capable of redirecting out-of-control vehicles.

- Power Poles:

It is recommended that all power poles be removed from shared rights-of-way (unless adequately guarded by energy absorbing barriers capable of redirecting out-of-control vehicles) and be required to relocate either underground or at mid-block locations.

- Motorcycle Helmet Chin Strap Fasteners:

It is recommended that quick release chin strap buckles be developed and required with improved reliability such as are now available for seat belts.

The Contract Manager has certified that the contractor's research, on thirty investigations, has been satisfactorily completed and that all contractual obligations have been met.

The opinions, findings, and conclusions expressed in this summary are those of the contractor and not necessarily those of the National Highway Traffic Safety Administration.

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# executive summary

## A SYNOPSIS OF A RECENTLY RELEASED NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION RESEARCH REPORT

### NOISE AND INFLATABLE RESTRAINT SYSTEMS

The purpose of this study was to analyze the available data on the impulsive noise created by the explosive means or the sudden pressurization of the inflatable restraint air bags required as "passive" crash protection for occupants of motor vehicles manufactured after August 15, 1973 for the front seats and for all seats by the end of 1975.

Contract DOT-HS-006-1-006  
Bolt, Beranek and Newman, Inc.  
50 Moulton Street  
Cambridge, Massachusetts 02138  
DOT/HS-800 474

Award Amount: \$16,500.00  
Date Report Due: 4-5-71  
Date Report Rec'd: 5-10-71

#### Background

One of the most promising types of passive restraint systems, i.e., systems requiring no action by the vehicle occupants, consists of inflatable air bags installed at each passenger position. As a collision occurs a fabric bag inflates with a bang; the passengers, thrown forward by the crash, are cushioned by this air bag. The rapid unfolding and inflating of the bag generates this loud "bang" or impulsive noise. Since the National Highway Traffic Safety Administration has announced that passive crash protection for occupants will be required in vehicles manufactured after August 15, 1973 for the front seats and all seats by 1975 the effect of the air bag inflation noise on hearing has been questioned.

#### Purpose of Study Defined

The purpose of this study has been threefold:

1. Establishing tentative criteria for exposure to air bag noise.
2. Finding the noise levels expected in the vehicles.
3. Estimating the percentage of the population, if any, whose hearing might be permanently affected by widespread exposure to the noise of inflatable restraint systems.

#### Tentative Criteria Establishment for the Study

To accomplish this, tentative criteria had to be determined that could be compared with the actual noise level measured in vehicles. If the noise level was found to be less than the criteria level then there would be no problem; however, if the noise level was found to exceed the criteria then the hearing of some of the population may be affected.

Existing criteria for noise exposure developed by the National Academy of Sciences were designed to protect a person's ability to understand speech. Of the two major criteria currently accepted (one for exposure to continuous noise and one for exposure to impulsive noise), neither could be used in their present form to evaluate exposure to air bag noise. The impulsive noise criterion was developed to evaluate exposure to weapons firing where an individual might fire a hundred rounds of ammunition in a day. This criterion was modified by taking into account the one-time exposure to air bag noise. The tentative criteria established for this study were formulated to protect 95% of the exposed population from permanent hearing impairment; the criterion can be extrapolated to other protection levels.

Since the government-proposed regulation requires passive protection at all seating positions for the 1976 and later cars, the actual noise exposure evaluated in

this study has been the bang expected by a full set of air bags going off in a car full of passengers. From 1970 test results reported by automobile and air bag manufacturers, it is concluded that the noise of the air bags then being developed by the various manufacturers exceeds the noise safety criteria determined for this study. It was also determined that these in-car noise levels would be greater than those used by Dr. Nixon of Wright-Patterson Air Force Base in his study of air bag noise (1969). The peak noise levels are not unlike the peak levels within 6 in. of the muzzle of a 12-gauge shotgun or within arm's length of a very large firecracker.

#### MAJOR CONCLUSIONS AND RECOMMENDATIONS

- The extent of hearing loss depends upon many factors including both the person's susceptibility to noise and the nature of the noise exposure. The information available in the scientific literature is not sufficient to conclusively predict the effects of air bag noise on passengers. However, two tentative estimates were made from this study:
  1. On the basis of a comparison of the noise due to a full set of the 1970 experimental air bags with the tentative criteria, it was estimated that 15% to 30% of the exposed population could experience hearing damage; adjusting the tentative criteria to be consistent with Dr. Nixon's experimental results, it was estimated that 7% to 16% of the population could be affected.
  2. On the basis of the limited scientific literature, personal experience, and the latest experience of

others currently doing research in the field, it was concluded that various special groups of people (the young, the aged, or those with hearing related problems) are not substantially different from the normal population. Therefore, it was felt that they are covered by the tentative criteria.

- The noise of air bag inflation can be reduced without affecting the safety performance. This noise reduction could be achieved through suitable design modifications of inflation devices and the bag itself. If the noise of the air bag were reduced by fifteen decibels (15 dB), it was estimated that less than 0.1% of the exposed population would experience hearing damage instead of the 7% to 30% estimated above.
- These tentative criteria should be refined by further experimental and theoretical studies. In particular, more studies should be made of hearing losses produced by noise of air bag restraint systems. A detailed acoustical analysis should be made of the air bag noise at each occupant position for realistic situations, especially for the case of a closed car with a full set of air bags.

The Contract Manager has certified that the contractor's work has been satisfactorily completed and that all contractual obligations have been met.

The opinions, findings, and conclusions expressed in this summary are those of the contractor and not necessarily those of the National Highway Traffic Safety Administration

Availability: This report may be ordered in paper copy (PC) or in microfiche (MF) from NTIS; order DOT/HS-800 474.

# U.S. DEPARTMENT OF TRANSPORTATION NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

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